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COMPUTING PROGRAMS FOR THE COMPLEX FRESNEL INTEGRAL

by

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ABSTRACT

The asymptotic series for the complex Fresnel integral with remainder is used in subroutines to evaluate the conventional Fresnel integrals and the probability integral. A series expansion with improved accuracy of calculation is used to evaluate the remainder.

A rational polynomial approximation is developed for the complex Fresnel integral. The range of validity of the rational approximation is that part of the complex plane on the negative side which is bounded by the imaginary axis and is outside a circle of unit radius.

The complex Fresnel integral correct to thirteen significant digits is tabulated at unit intervals in the argument.

FOREWORD

The work which is covered by this report was performed in the Mathematical Physics Branch partly under the Foundational Research Program of the Naval Weapons Laboratory and partly under a project established at the Naval Weapons Laboratory by the Office of Naval Research (ONR Project NR 062-203). Assistance in the programming was contributed by E. J. Hershey and by W. H. Langdon. The date of completion was 25 January 1962.

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/s/ R. H. LYDDANE
Technical Director

INTRODUCTION

The Fresnel integrals and the probability or error integral have a common origin insofar as they can be generated from a single complex integral. Various forms of complex integral with different constants of integration may be utilized. Throughout the present report the complex Fresnel integral $E(z)$ for complex argument z will be defined by the equation

$$E(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} \frac{e^{t}}{t^{\frac{1}{2}}} \, dt \tag{1}$$

where the path of integration lies within that part of the complex plane from which the positive real axis is excluded. The phase of z is limited to the range 0 to 2π, and the phase of $z^{\frac{1}{2}}$ is half the phase of z.

The conventional Fresnel integrals are defined in terms of harmonic functions by the equations

$$C(v) + iS(v) = \int_{0}^{v} e^{\frac{1}{2}\pi i u^{2}} \, du = \int_{0}^{v} i^{u^{2}} \, du \tag{2}$$

or are expressed in terms of Hankel functions by the equations

$$C(x) + iS(x) = \frac{1}{\sqrt{2\pi}} \int_{0}^{x} \frac{e^{iu}}{u^{\frac{1}{2}}} \, du = \frac{i}{2} \int_{0}^{x} H_{\frac{1}{2}}^{(1)}(u) \, du \tag{3}$$

where x and v are related by the equation

$$x = \frac{1}{2} \pi v^{2} \tag{4}$$

The conventional integrals are recovered from the complex integral through the transformations

$$t = iu \qquad\qquad z = ix \tag{5}$$

and are expressed by the equation

$$C(x) + iS(x) = \frac{1}{2} + \frac{i}{2} + \frac{(1 - i)}{\sqrt{2}} E(ix) \tag{6}$$

The transformations

$$t = -u^2 \qquad\qquad z = -x^2 \tag{7}$$

give the error function of real argument,

$$H(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-u^2} du = 1 - i\sqrt{2}\, E(-x^2) \tag{8}$$

and the transformations

$$t = + u^2 \qquad\qquad z = + x^2 \tag{9}$$

give the error function of imaginary argument,

$$-iH(ix) = \frac{2}{\sqrt{\pi}} \int_0^x e^{u^2} du = i + \sqrt{2}\, E(+x^2) \tag{10}$$

Values of the Fresnel integrals and the probability integral are to be found in a few published tables.[1 - 4*] It is believed that Fresnel integrals of complex argument have not appeared heretofore.

Tables are too bulky for use on a high speed calculator, and a compact subroutine is generally to be preferred for machine computations.

The complex Fresnel integral is given by an absolutely convergent series for all values of the argument, but for large arguments the terms of the series increase with order before they finally decrease.

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*Superscripts in the text refer to similarly numbered entries in the list of references.

The rounding error in the sum is contributed by the largest terms and increases with increase of argument. The integral has an asymptotic series where the terms decrease with order at first but finally increase. The truncation error diminishes with increase in argument. There is an intermediate range of argument where neither series is effective. This region of difficulty can be spanned by a rational polynomial approximation. Insofar as the complex Fresnel integral and its rational approximation are both analytic throughout a finite region in the complex plane, the error in the approximation is also analytic in the same region. The absolute value of an analytic function within a closed boundary is everywhere less than the maximum absolute value of the function on the boundary. The approximation therefore is so adjusted as to make the error less than a tolerance everywhere on the boundary of the region of approximation.

A rational approximation which is valid over the negative half of the complex plane outside a circle of unit radius has been so constructed by the method of inverted differences as to have an absence of error at nodal points on the boundary. Between each pair of nodal points there was a maximum of error, and the nodal points were so adjusted as to equalize the maxima of error. The distribution of error was thus optimized in accordance with the Chebyshev criterion.

In previous work [7], the adjustment of spacing between nodes was computed solely from the intermediate maximum of error. There was a seichelike instability in the motion of the nodes. In current work, the adjustment of each node is derived from an entire matrix. The instability is no longer apparent in the motion of the nodes.*

A smaller bound of error could have been achieved if the error had been allowed to be finite instead of null between the maxima. The rational approximation then would be specified at antinodal points in

* These methods will be documented in a later report.

the error curve. An antinodal specification has been used successfully on the real axis by Murnaghan and Wrench.[5] The problem of controlling a profusion of maxima along a complex contour looks formidable.

The rational approximation has been incorporated in a subroutine for use on the Naval Ordnance Research Calculator. Two additional subroutines give the conventional probability integral or give the conventional Fresnel integrals. Formulations and instructions for the subroutines are presented in the present report.

The NORC does floating decimal arithmetic with 13 digit numbers at the average rate of 15000 operations per second in response to three address instructions.

General purpose subroutines in the current programming are designed to confine the error in a function to the thirteenth digit unless one unit error in the last digit of the argument would be responsible for a larger inherent error in the function. Inasmuch as the majority of terms in a series expansion have decimal exponents at least one unit lower than the decimal exponent of the principal terms, the smaller terms are summed first and the principal terms are added last.

The sequence of computations is arranged as far as possible so that the decimal coefficients of all numbers are just less than unity where the relative rounding error is least.

ANALYSIS

The path of integration in Equation (1) may be varied in accordance with the equation

$$E(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} \frac{e^{t}}{t^{\frac{1}{2}}}\, dt + \frac{1}{\sqrt{2\pi}} \int_{0}^{z} \frac{e^{t}}{t^{\frac{1}{2}}}\, dt \qquad (11)$$

The integrand in Equation (11) can be expanded as an ascending power series. Term by term integration of the series leads to the equation

$$E(z) = -\frac{i}{\sqrt{2}} + \left(\frac{2z}{\pi}\right)^{\frac{1}{2}} \sum_{m=0}^{\infty} \frac{z^m}{(2m+1)m!} \tag{12}$$

The series in Equation (12) is absolutely convergent for all values of z, but the largest term in the series increases with increase in $|z|$.

Successive integrations by parts in Equation (1) lead to the equation

$$E(z) = \frac{e^z}{(2\pi z)^{\frac{1}{2}}} \sum_{m=0}^{m=N-1} \frac{(2m)!}{2^{2m} m!\, z^m} + R(z) \tag{13}$$

in which the remainder $R(z)$ is defined by the equation

$$R(z) = \frac{(2N)!}{\sqrt{2\pi}\; 2^{2N} N!} \int_{-\infty}^{z} \frac{e^t}{t^{N+\frac{1}{2}}}\, dt \tag{14}$$

The series in Equation (13) is asymptotic and the error in the series is not much smaller than the smallest term. Improved accuracy is achieved if the series is terminated with half the smallest term. Evaluation of the remainder would remove the error in the asymptotic series. A term by term comparison between Equations (12) and (13) establishes a series expansion for the remainder, which is given by the equation

$$R(z) = -\frac{i}{\sqrt{2}} + \left(\frac{2z}{\pi}\right)^{\frac{1}{2}} \frac{(2N)!}{2^{2N} N!} \sum_{m=0}^{m=\infty} \frac{z^{m-N}}{(2m+1-2N)m!} \tag{15}$$

The last term of the series in Equation (15) is a minimum if N is so chosen that

$$N - \frac{3}{2} < |z| < N - \frac{1}{2} \tag{16}$$

The terms of the series in Equation (15) then increase until $m = N - 1$ then decrease after $m = N$. The largest terms in the series are on the order of unity, and the accuracy with which $R(z)$ can be computed is essentially constant.

The inherent errors in Equations (12) and (13) are compared in Figure 1, Appendix A. Curve E represents the Fresnel integral itself on the negative real axis. Curve H illustrates the rounding error in the largest term of the absolutely convergent series. Curve A illustrates the smallest term in the asymptotic series. Curve R illustrates the accuracy which could be achieved by a rational approximation.

Accurate values of the complex Fresnel integral for equally spaced arguments have been calculated with double precision by direct integration in the complex plane. Sixteen point Gaussian integration was used for each unit interval. The integration multipliers for the Gaussian integration were taken from Reference 6. The overall accuracy of the integrations was checked against double precision values which were computed from the ascending power series at $|z| = 1$. The double precision values have been rounded to thirteen digits and the rounded values are tabulated in Table 5, Appendix B.

The zone of approximation for the complex Fresnel integral is the area A in Figure 4. The infinite zone of approximation was reduced to a finite zone of approximation by the inversion

$$\bar{z} = \frac{1}{z} \tag{17}$$

which exchanges the area A for the area B in Figure 4. The complex Fresnel integral $E(z)$ was exchanged for the monotonic function $F(\bar{z})$ which is defined by the equation

$$F(\bar{z}) = (2\pi z)^{\frac{1}{2}} e^{-z} E(z) \tag{18}$$

The function $F(\bar{z})$ is expressed in terms of two polynomials $p(\bar{z})$ and $q(\bar{z})$ by the equation

$$F(\bar{z}) = \frac{p(\bar{z})}{q(\bar{z})} \tag{19}$$

while the polynomials themselves are defined by the equations

$$p(\bar{z}) = \sum_{m=0}^{m=N} a_m \bar{z}^m \tag{20}$$

$$q(\bar{z}) = \sum_{m=0}^{m=N} c_m \bar{z}^m \tag{21}$$

in the rational polynomial approximation of the Nth degree there are $2N + 1$ complex coefficients which are specified by the $2N + 1$ complex values of the function to be approximated, at $2N + 1$ nodes on the half circle contour of B. The function $F(\bar{z})$ is symmetric with respect to the real axis and the polynomials $p(\bar{z})$ and $q(\bar{z})$ have real coefficients. Values of the function on the positive quarter circle are sufficient to establish the real coefficients. The coefficients of $p(\bar{z})$ and $q(\bar{z})$ were determined by a double precision complex subroutine which used the method of inverted differences.

The origin at $\bar{z} = 0$ and the corners at $\bar{z} = \pm i \frac{\pi}{2}$ were included among the nodes, and since there must be an odd number of nodes, the point at $z = -1$ could not be a node. For each order of approximation the locations of the other nodes were adjusted until the maxima of

error between nodes were uniform. The number of nodes on the imaginary axis or the number of nodes on the half circle was increased according to whichever line had the largest maxima of error until $N = 13$.

The function $F(\bar{z})$ was finally approximated to within relative errors as listed in the following table:

Line	Number of Nodes	Maximum Error Between Nodes
Imaginary Axis	19	5.6×10^{-13}
Half Circle	8	2.5×10^{-13}

The variation of error along the contour of approximation is plotted in Figure 5.

The coefficients of the polynomials and useful ratios between the coefficients are listed to thirteen digits in Tables 1 to 4, Appendix B.

That the error in the rational polynomial approximation is truly analytic within the zone of approximation is verified by a determination of the roots of $q(\frac{1}{z})$, which are all found to lie outside the zone of approximation. The roots are represented by dots in Figure 4.

The rational polynomial approximation and the absolutely convergent series have been extrapolated beyond their zones of validity to an empirical boundary where the two approximations give comparable accuracy. The accuracy of this extrapolation is at worst one digit less than the inherent accuracy for one unit error in the thirteenth digit of the argument. The relative errors in the range of worst error are illustrated in Figure 6. The errors in Figure 6 are actual values for a subroutine which uses the rational polynomial in areas A + D but uses the convergent series in areas B + C of Figure 4.

PROBABILITY INTEGRAL ROUTINE

Operation

The routine computes the probability integral from a given argument.

Formulation

The probability integral or error function $H(x)$ is calculated for either positive or negative argument x with the equation

$$H(x) = -\frac{e^{-x^2}}{x\sqrt{\pi}} \sum_{m=0}^{m=N-1} \frac{(-1)^m (2m)!}{2^{2m} m!\, x^{2m}} + R(x) \tag{22}$$

The summation in Equation (22) is not cycled if $x^2 < \frac{3}{2}$. Otherwise the summation is cycled until $x^2 < N + \frac{3}{2}$, or until the terms in the summation become less than 10^{-18}. The order N is even because the terms are computed in pairs.

If the final asymptotic term is more than 10^{-18}, then the remainder $R(x)$ is computed with the equation

$$R(x) = \frac{2}{\sqrt{\pi}} \frac{(2N)!}{2^{2N} N!} \sum_{k=0}^{k=N-1} \frac{(-1)^k x^{2k+1-2N}}{(2k+1-2N)k!}$$

$$+ \frac{2}{\sqrt{\pi}} \frac{(2N)!}{2^{2N} N!} \sum_{k=0}^{k\to\infty} \frac{(-1)^{N+k}\, x^{2k+1}}{(2k+1)(N+k)!} \tag{23}$$

Only the last summation in Equation (23) is cycled with $N = 0$ if $x^2 < \frac{3}{2}$. In any case, the last summation is cycled in two parts, for $k \leq 2$, and for $k > 2$, in order to minimize the accumulation of rounding error. In the combination of summations and remainders the program

utilizes the sequence

$$\left(\frac{2}{\sqrt{\pi}} - 1 \right) \frac{\sqrt{\pi}}{2} R + \Sigma + \frac{\sqrt{\pi}}{2} R \tag{24}$$

whose terms are all less than unity and therefore are free from extreme rounding error.

If the final asymptotic term is less than 10^{-13}, then the remainder $R(x)$ is given by the equation

$$R(x) = \pm 1 \tag{25}$$

where the sign is the same as the sign of x .

Library Code

Block 0078 in Deck 2500 contains the NORC code. Beginning of block words and assembly instructions are as follows:

Program	BOB	0991	0101	0191	0078
Guide Words	Block	0079			
Subroutines (exp)	BOB	0994	0192	0241	0058

Input

a. The argument x in memory location X.

Output

a. The function $H(x)$ in memory location Y.

Call Lines

L	0060	$L + 1$	-	0101
$L + 1$	Y	C	-	X

Exit Line — The program returns control to C.

Limitations

a. Data on the accuracy are plotted in Figure 2, Appendix A.

Time

a. A representative time to compute each value of the function is 32 milliseconds.

FRESNEL INTEGRAL ROUTINE

Operation

The routine computes the Fresnel integrals from a given argument.

Formulation

The Fresnel integrals are computed with the equations

$$S(x) = p(x)\sin x - q(x)\cos x + P(x) \tag{26}$$

$$C(x) = q(x)\sin x + p(x)\cos x + Q(x) \tag{27}$$

in which $p(x)$ and $q(x)$ are defined by the equation

$$q(x) + ip(x) = \frac{1}{(2\pi x)^{\frac{1}{2}}} \sum_{m=0}^{m=N-1} \frac{(2m)!}{2^{2m} m!\,(ix)^m} \tag{28}$$

The summation in Equation (28) is not cycled if $x < \frac{3}{2}$. Otherwise the summation is cycled until $x < N + \frac{3}{2}$ or until the smallest term in $p(x)$ is less than 10^{-13}. The order N is even because the terms are computed in pairs.

If the final term of $p(x)$ is more than 10^{-13}, then the remainders $P(x)$ and $Q(x)$ are evaluated with the equation

$$Q(x) + iP(x) = \left(\frac{2x}{\pi}\right)^{\frac{1}{2}} \frac{(2N)!}{2^{2N}N!} \sum_{k=0}^{k=N-1} \frac{(ix)^{k-N}}{(2k+1-2N)k!}$$

$$+ \left(\frac{2x}{\pi}\right)^{\frac{1}{2}} \frac{(2N)!}{2^{2N}N!} \sum_{k=0}^{k\to\infty} \frac{(ix)^k}{(2k+1)(N+k)!} \tag{29}$$

Only the last summation in Equation (29) is cycled with $N = 0$ if $x < \frac{3}{2}$. In any case, the last summation is cycled in two parts, for $k \leq 2$ and for $k > 2$, in order to minimize the accumulation of rounding error.

If the final term of $p(x)$ is less than 10^{-13}, then the remainders $P(x)$ and $Q(x)$ are given by the equation

$$Q(x) + iP(x) = \frac{1}{2} + \frac{1}{2}i \tag{30}$$

In each cycle of summation a real term and an imaginary term are calculated and are added to the real and imaginary parts of the sum.

Library Code

Block 0080 in Deck 2500 contains the NORC code. Beginning of block words and assembly instructions are as follows:

Program		BOB	0991	0101	0225	0080
Guide Words		Block	0081			
Subroutines	(sin-cos)	BOB	0994	0226	0274	0010
	(sq rt)	BOB	0994	0275	0300	0052

Input

a. The argument x in memory location X.

Output

a. The function $S(x)$ in memory location S.

b. The function $C(x)$ in memory location C.

Call Lines

L	0060	L	-	0101
$L + 1$	S	C	-	X

Exit Line — The program returns control to $L + 2$.

Limitations

a. The argument x must be positive. Otherwise a program stop will occur in the square root subroutine.

b. Data on the accuracy are plotted in Figure 3, Appendix A.

Modification

a. If $(2x/\pi)^{\frac{1}{2}}$ is already in memory location V, modify location 0112 as follows and jettison block 0052.

0112 0060 V 0200 0115

Time

a. A representative time to compute each pair of values of the functions is 68 milliseconds.

COMPLEX FRESNEL INTEGRAL ROUTINE

Operation

The routine computes a complex Fresnel integral from a given complex argument.

Formulation

The complex argument z is given in terms of its parts x, y by the equation

$$z = x + iy \tag{31}$$

where the phase of z is taken to be less than 2π.

If the arguments x, y satisfy either of the inequalities

$$x^2 + y^2 < 1 \qquad - x + .02x^2 + .044y^2 < 0 \tag{32}$$

then the complex Fresnel integral $E(z)$ is given by the equation

$$E(z) = - \frac{i}{\sqrt{2}} + \left(\frac{2z}{\pi} \right)^{\frac{1}{2}} \sum_{m=0}^{\infty} \frac{z^m}{(2m + 1)m!} \tag{33}$$

in which the summation is cycled until there is no change in the sum.

If the arguments x, y satisfy both of the inequalities

$$x^2 + y^2 \geq 1 \qquad - x + .02x^2 + .044y^2 \geq 0 \tag{34}$$

then the complex Fresnel integral $E(z)$ is given by the equation

$$E(z) = \frac{e^z}{(2\pi z)^{\frac{1}{2}}} \frac{p(\frac{1}{z})}{q(\frac{1}{z})} \tag{35}$$

for which the polynomials $p(\frac{1}{z})$ and $q(\frac{1}{z})$ are defined by the equations

$$p(\frac{1}{z}) = \sum_{m=0}^{m=13} a_m (\frac{1}{z})^m \tag{36}$$

$$q(\frac{1}{z}) = \sum_{m=0}^{m=13} c_m (\frac{1}{z})^m \tag{37}$$

The summations in Equations (36), (37) are cycled until $q(\frac{1}{z})$ remains unchanged or until $m = 13$. The summation is accomplished by a computing loop which utilizes the quotients between coefficients in Tables 3 and 4, Appendix B.

Modification

The routine computes $E(z) + \frac{i}{\sqrt{2}}$ if instructions are modified as follows

loc	*PQ*	*R*	*S*	*T*
0208	5025	0251	0252	0290
0243	9660	0252	0290	0209

CONCLUSION

The complex Fresnel integral can be evaluated over the entire range of argument by polynomial approximations to within the inherent error of the argument without resorting to double precision.

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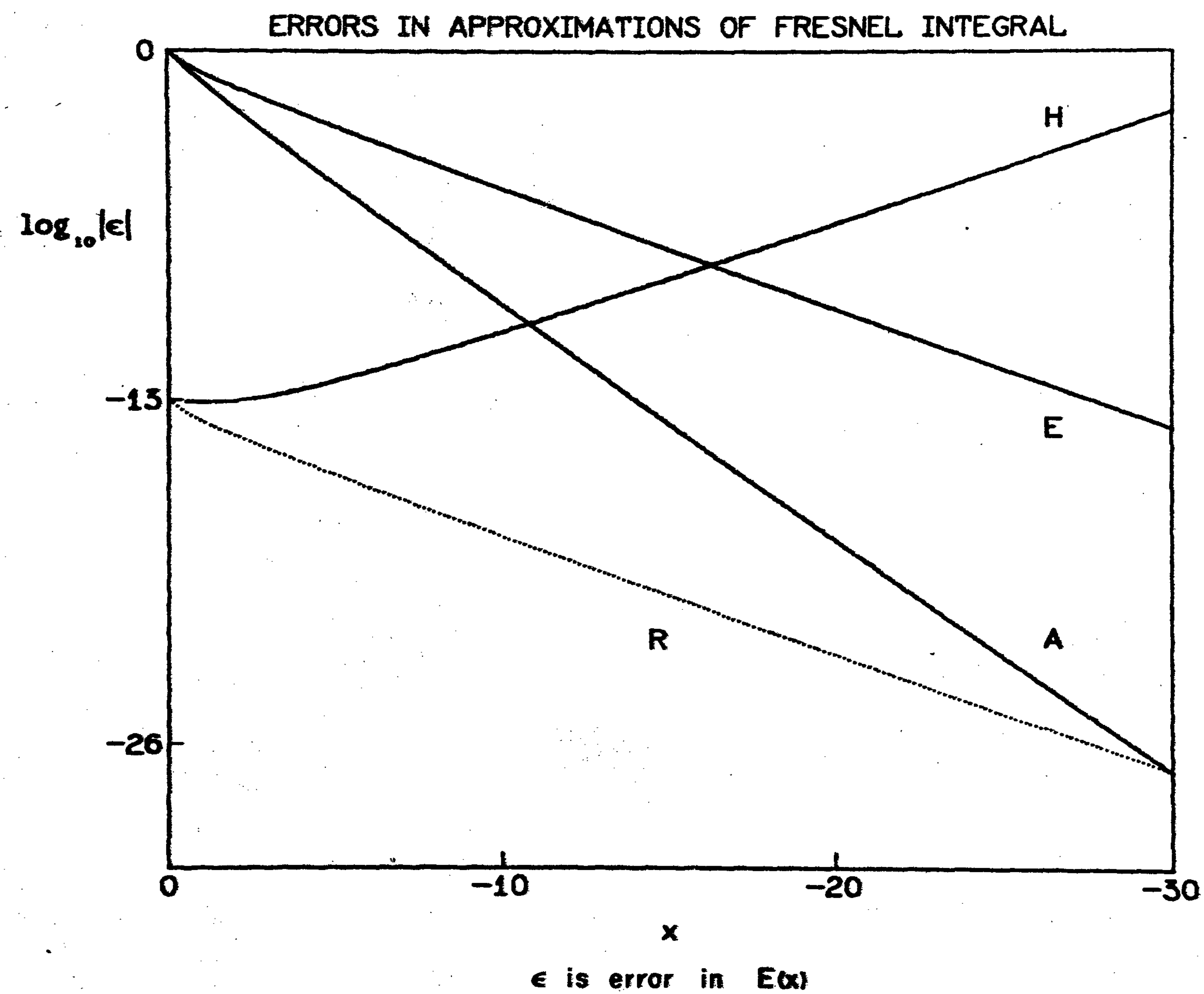
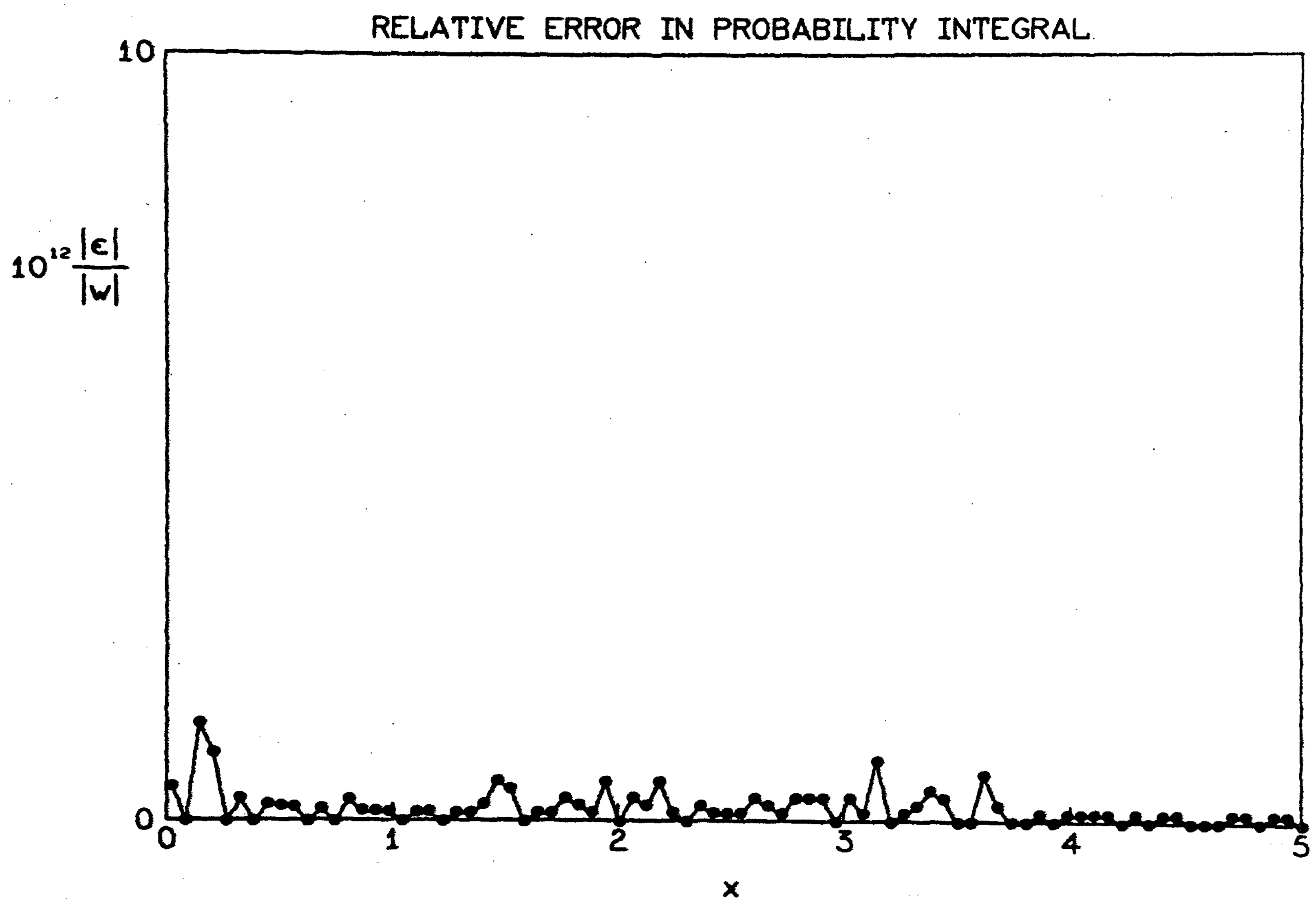
APPENDIX A



ERRORS IN APPROXIMATIONS OF FRESNEL INTEGRAL
0
-13
-26
log₁₀|ε|
H
E
R
A
0
-10
-20
-30
x
ε is error in E(x)

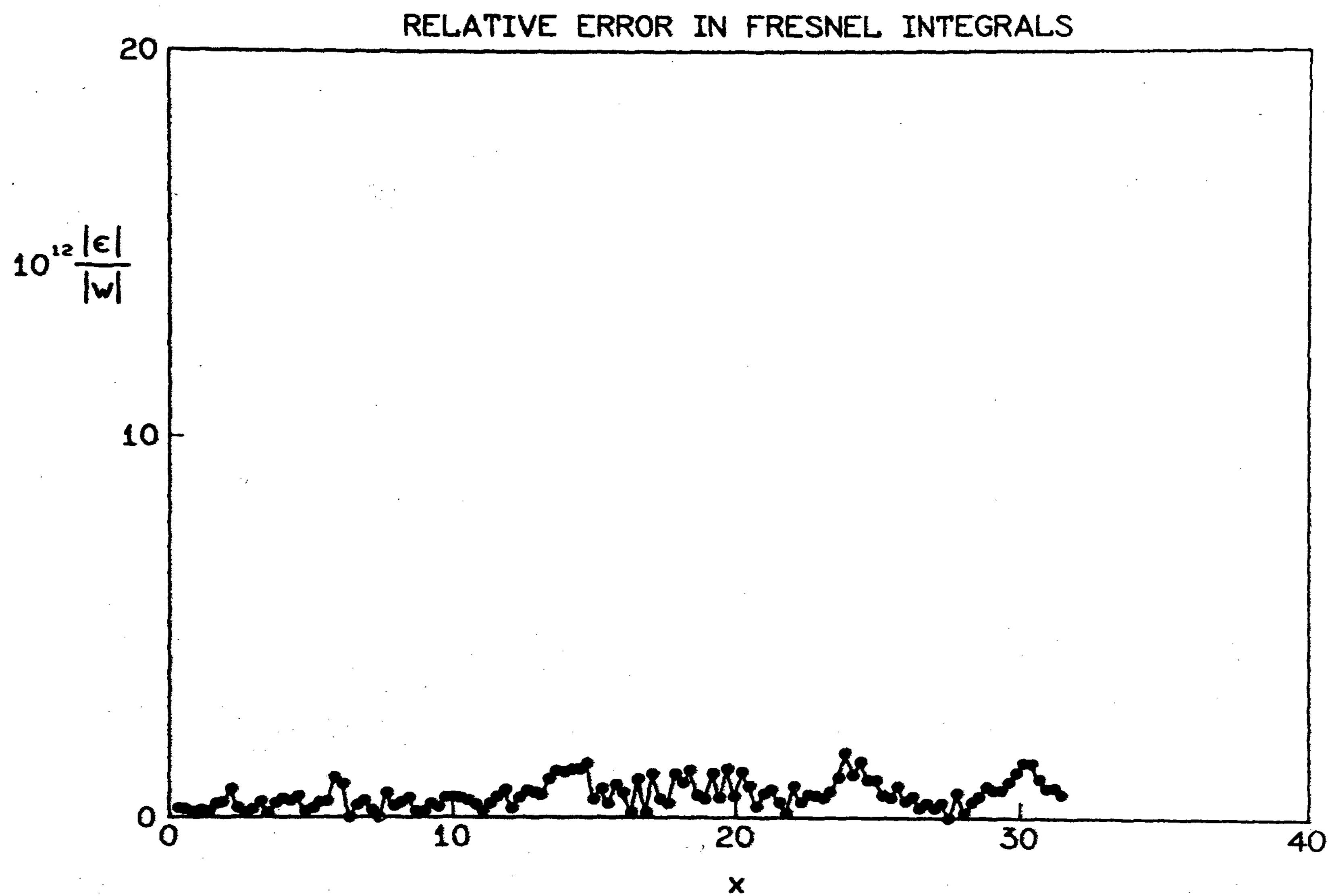
Figure 1



$w = H(x)$

ϵ is error in w as calculated by subroutine 0078

Figure 2



$w = C(x) + i S(x)$

ϵ is error in w as calculated by subroutine 0080

Figure 3

ZONES OF APPROXIMATION OF COMPLEX FRESNEL INTEGRAL

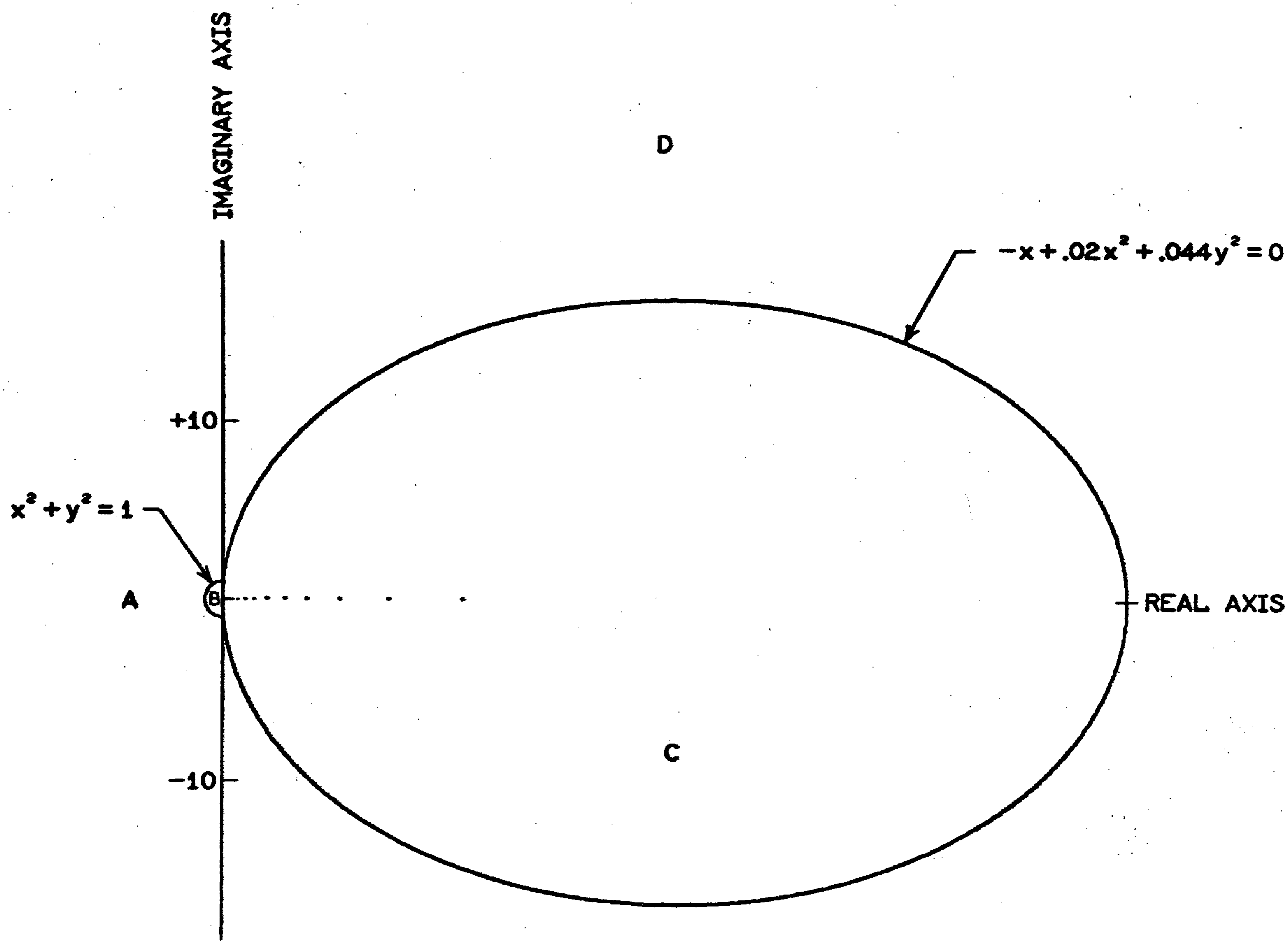
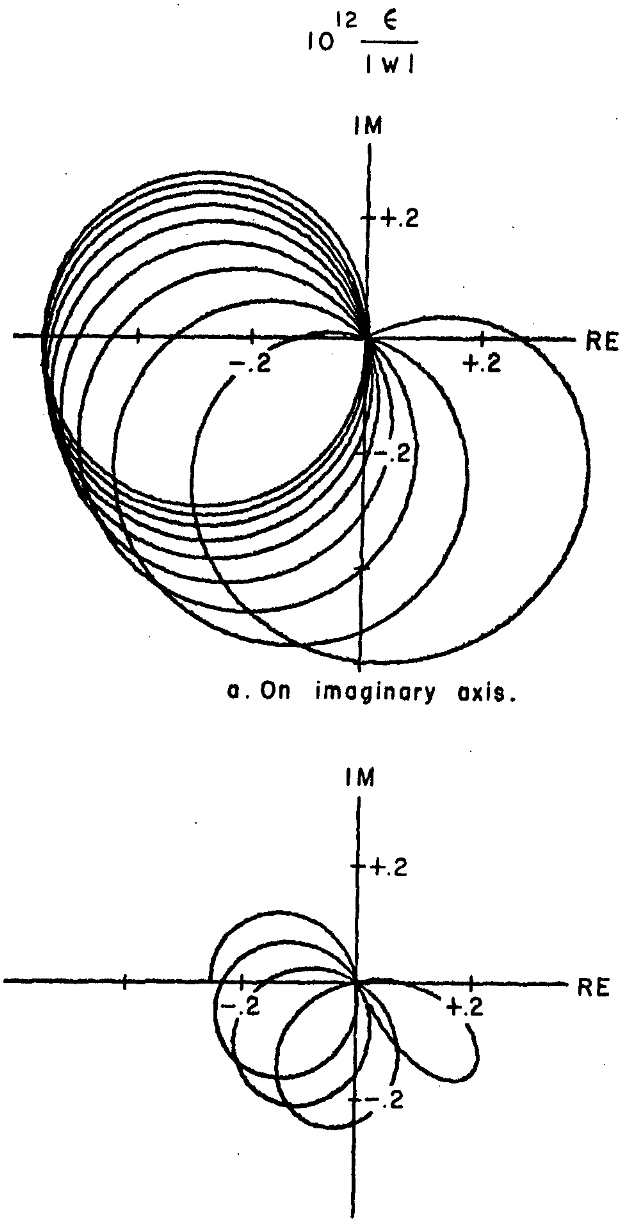


Figure 4

RELATIVE ERROR IN RATIONAL POLYNOMIAL APPROXIMATION



a. On imaginary axis.

b. On circle $|z| = 1$.

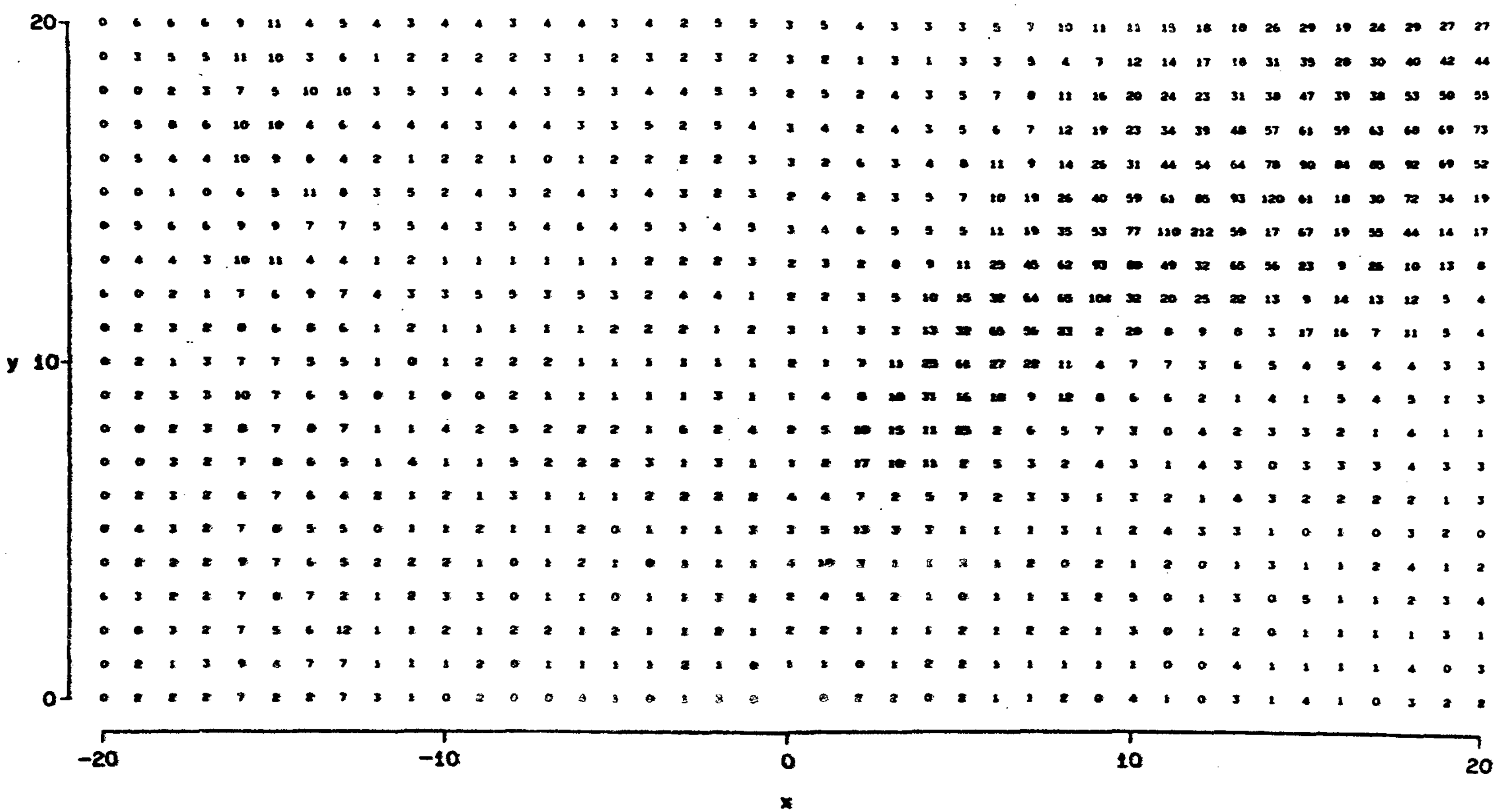
$$w = E(z)$$

ε is the error in the double precision approximation of w .

Figure 5.

RELATIVE ERROR IN COMPLEX FRESNEL INTEGRAL

$10^{12}\frac{|\varepsilon|}{|w|}$



$w = E(z)$ ε is error in w as calculated by subroutine 0148 $z = x + iy$

Figure 6.

APPENDIX B

TABLES

Each number in the tables contains the sign of the number and the decimal coefficient, followed by the exponent of ten by which the decimal coefficient is to be multiplied.

TABLE 1

COEFFICIENTS OF THE POLYNOMIAL $p(1/z)$

a_0	+ 1.0000 0000 0000	0
a_1	- 4.3072 3024 0996	1
a_2	+ 7.5767 0484 7754	2
a_3	- 7.1538 6843 1803	3
a_4	+ 4.0107 3550 9019	4
a_5	- 1.3957 8448 9703	5
a_6	+ 3.0642 1593 2238	5
a_7	- 4.2299 8816 6090	5
a_8	+ 3.5959 8801 4722	5
a_9	- 1.8050 4449 9502	5
a_{10}	+ 4.9680 4778 3506	4
a_{11}	- 6.5607 3082 6910	3
a_{12}	+ 3.1540 1992 8001	2
a_{13}	- 2.3387 8052 9458	0

TABLE 2

COEFFICIENTS OF THE POLYNOMIAL $q(1/z)$

c_0	+ 1.0000 0000 0000	0
c_1	- 4.3572 3024 0991	1
c_2	+ 7.7870 6635 9836	2
c_3	- 7.5124 1752 2806	3
c_4	+ 4.3354 6694 4864	4
c_5	- 1.5682 5133 2873	5
c_6	+ 3.6241 8007 0887	5
c_7	- 5.3555 3415 7881	5
c_8	+ 4.9855 2523 2833	5
c_9	- 2.8296 1157 2383	5
c_{10}	+ 9.2431 4330 3151	4
c_{11}	- 1.5724 9356 9766	4
c_{12}	+ 1.1539 4785 3548	3
c_{13}	- 2.3345 8467 6245	1

TABLE 3

RATIOS BETWEEN THE COEFFICIENTS OF POLYNOMIAL $q(1/z)$

c_0	+ 1.0000 0000 0000	0
c_1/c_0	- 4.3572 3024 0991	1
c_2/c_1	- 1.7871 5971 5954	1
c_3/c_2	- 9.6473 0127 5810	0
c_4/c_3	- 5.7710 6761 1327	0
c_5/c_4	- 3.6172 6050 0005	0
c_6/c_5	- 2.3109 6890 8438	0
c_7/c_6	- 1.4777 2297 5440	0
c_8/c_7	- 9.3091 0920 5281	- 1
c_9/c_8	- 5.6756 5389 8507	- 1
c_{10}/c_9	- 3.2665 7672 5005	- 1
c_{11}/c_{10}	- 1.7012 5412 7727	- 1
c_{12}/c_{11}	- 7.3383 3114 3189	- 2
c_{13}/c_{12}	- 2.0231 2840 1399	- 2

TABLE 4

RATIOS BETWEEN THE COEFFICIENTS OF POLYNOMIALS $p(1/z)$ AND $q(1/z)$

a_0/c_0	1.0000 0000 0000	0
a_1/c_1	9.8852 4820 3035	- 1
a_2/c_2	9.7298 5781 5047	- 1
a_3/c_3	9.5227 2475 5494	- 1
a_4/c_4	9.2509 8855 5619	- 1
a_5/c_5	8.9002 6018 4351	- 1
a_6/c_6	8.4549 2186 4542	- 1
a_7/c_7	7.8983 4970 9645	- 1
a_8/c_8	7.2128 5691 4333	- 1
a_9/c_9	6.3791 2467 2512	- 1
a_{10}/c_{10}	5.3748 4665 1801	- 1
a_{11}/c_{11}	4.1721 8292 8473	- 1
a_{12}/c_{12}	2.7332 4303 0268	- 1
a_{13}/c_{13}	1.0017 9725 8954	- 1

TABLE 5

$$E(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} \frac{e^{t}}{t^{\frac{1}{2}}}\, dt$$

$$z = x + iy$$

$$x = -20\ (1)\ +20$$

$$y = 0\ (1)\ 20$$

COMPLEX FRESNEL INTEGRAL TABLE

Y		X = -20		-19		-18		-17	
0	RE	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0
	IM	-1.7957 8859 7310	-10	-5.0024 0083 0536	-10	-1.3952 4562 8082	-9	-3.8970 1202 0407	-9
1	RE	1.5329 5041 0689	-10	4.2730 9271 7164	-10	1.1927 0706 7775	-9	3.3340 0967 3875	-9
	IM	-9.3340 0781 8312	-11	-2.5948 3436 4177	-10	-7.2210 8370 6848	-10	-2.0118 2027 2982	-9
2	RE	1.5918 5209 8689	-10	4.4278 0670 5481	-10	1.2329 5429 2165	-9	3.4373 4598 0840	-9
	IM	8.2231 8981 2346	-11	2.3006 8423 0491	-10	6.4476 6350 8442	-10	1.8103 5180 3243	-9
3	RE	1.2573 5485 7283	-11	3.3256 2654 8503	-11	8.7312 9320 2370	-11	2.2701 2189 3428	-10
	IM	1.7822 3261 4560	-10	4.9632 5675 6223	-10	1.3838 4074 2679	-9	3.8634 3726 4057	-9
4	RE	-1.4505 3894 1195	-10	-4.0502 1859 1169	-10	-1.1325 1006 0329	-9	-3.1716 4037 7657	-9
	IM	1.0311 8917 3671	-10	2.8511 8578 9746	-10	7.8863 6211 7789	-10	2.1821 3007 2314	-9
5	RE	-1.6278 5844 7564	-10	-4.5172 2955 9413	-10	-1.2544 5976 7338	-9	-3.4864 7949 7232	-9
	IM	-6.9750 0634 4092	-11	-1.9658 8927 5626	-10	-5.5525 6253 7918	-10	-1.5719 7277 0464	-9
6	RE	-2.5205 5776 6984	-11	-6.6862 5922 5954	-11	-1.7625 1206 0850	-10	-4.6084 0721 4154	-10
	IM	-1.7424 8178 5860	-10	-4.8489 5279 9649	-10	-1.3507 1155 0683	-9	-3.7665 4520 8106	-9
7	RE	1.3457 1025 6296	-10	3.7621 7313 9620	-10	1.0531 9948 9469	-9	2.9526 6424 4656	-9
	IM	-1.1167 5491 2819	-10	-3.0746 2576 8472	-10	-8.4637 6923 7769	-10	-2.3292 8309 5963	-9
8	RE	1.6427 3253 6806	-10	4.5479 8836 5283	-10	1.2596 7801 5317	-9	3.4904 2928 8103	-9
	IM	5.5985 3204 1569	-11	1.5923 3990 7171	-10	4.5391 0808 3527	-10	1.2970 3119 0591	-9
9	RE	3.7871 0993 7253	-11	1.0085 9083 9096	-10	2.6727 9988 4962	-10	7.0391 8173 4777	-10
	IM	1.6789 3339 2442	-10	4.6675 1263 2360	-10	1.2985 8386 1796	-9	3.6157 3307 0223	-9
10	RE	-1.2211 3745 2449	-10	-3.4172 6307 9356	-10	-9.5742 1983 5510	-10	-2.6857 3924 3395	-9
	IM	1.1909 1228 3787	-10	3.2688 0375 8467	-10	8.9680 4682 3269	-10	2.4589 0405 2841	-9
11	RE	-1.6385 1964 3164	-10	-4.5272 5015 0577	-10	-1.2511 0408 0707	-9	-3.4578 4007 2842	-9
	IM	-4.1174 0389 2400	-11	-1.1869 5847 3556	-10	-3.4281 7127 8449	-10	-9.9204 3783 9713	-10
12	RE	-5.0429 4443 0611	-11	-1.3486 8584 7745	-10	-3.5935 5571 2645	-10	-9.5320 3256 6766	-10
	IM	-1.5946 8238 1331	-10	-4.4289 3290 8836	-10	-1.2307 2135 1322	-9	-3.4217 6100 8385	-9
13	RE	1.0804 3486 7814	-10	3.0266 9379 3568	-10	8.4870 8726 9993	-10	2.3821 7382 6367	-9
	IM	-1.2537 1596 1978	-10	-3.4344 0755 1428	-10	-9.4025 5864 4532	-10	-2.5722 8526 7856	-9
14	RE	1.6169 1601 9824	-10	4.4605 3268 4760	-10	1.2305 1714 2193	-9	3.3943 8731 7878	-9
	IM	2.5653 1789 8246	-11	7.5994 1527 6357	-11	2.2512 3023 7699	-10	6.6693 2520 3169	-10
15	RE	6.2647 7553 3494	-11	1.6819 7216 4633	-10	4.5035 4846 5212	-10	1.2020 1096 6391	-9
	IM	1.4928 2751 9851	-10	4.1427 5498 5376	-10	1.1500 7602 7336	-9	3.1937 8903 6134	-9
16	RE	-9.2747 2410 2278	-11	-2.6021 4424 2149	-10	-7.3061 6176 7884	-10	-2.0528 8424 6599	-9
	IM	1.3044 7736 1491	-10	3.5694 0441 6092	-10	9.7608 9234 6663	-10	2.6672 6054 7211	-9
17	RE	-1.5790 8775 7500	-10	-4.3512 5048 9116	-10	-1.1988 9356 1337	-9	-3.3027 6424 7480	-9
	IM	-9.7992 8453 3119	-12	-3.2256 7556 0164	-11	-1.0424 6920 5623	-10	-3.3217 6116 9712	-10
18	RE	-7.4248 9134 0410	-11	-2.0001 1467 3073	-10	-5.3773 0911 3851	-10	-1.4424 3823 1906	-9
	IM	-1.3761 3564 4755	-10	-3.8170 5650 7786	-10	-1.0590 0019 4855	-9	-2.9386 2742 1401	-9
19	RE	7.6594 3783 2271	-11	2.1543 9637 0263	-10	6.0630 0236 1063	-10	1.7071 1732 2987	-9
	IM	-1.3420 7758 1564	-10	-3.6702 6646 0657	-10	-1.0031 6290 4111	-9	-2.7400 4864 3971	-9
20	RE	1.5258 0607 5454	-10	4.2013 4871 7991	-10	1.1566 8652 0992	-9	3.1838 6737 8116	-9
	IM	-6.0177 4321 7879	-12	-1.1432 0141 7488	-11	-1.6614 3074 9073	-11	-2.7566 3505 9871	-12

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		-16		-15		-14		-13	
0	RE	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0
	IM	-1.0901 6476 0859	-8	-3.0550 2872 6056	-8	-8.5782 9779 4927	-8	-2.4141 8528 8655	-7
1	RE	9.3350 6149 5409	-9	2.6186 3306 6787	-8	7.3611 7408 5737	-8	2.0742 7067 1929	-7
	IM	-5.6120 1728 5756	-9	-1.5676 4637 6100	-8	-4.3857 2561 3424	-8	-1.2290 6375 8542	-7
2	RE	9.5955 4521 4274	-9	2.6825 4038 8042	-8	7.5114 2858 3128	-8	2.1070 7080 4829	-7
	IM	5.0937 9399 2949	-9	1.4366 7985 2212	-8	4.0631 8474 2604	-8	1.1527 6632 8538	-7
3	RE	5.8248 1862 3756	-10	1.4671 2580 4106	-9	3.5960 3308 2283	-9	8.4451 3232 0600	-9
	IM	1.0801 6219 8198	-8	3.0248 1957 4427	-8	8.4856 3197 2281	-8	2.3852 5504 3917	-7
4	RE	-8.8976 9313 6208	-9	-2.5009 6325 5295	-8	-7.0448 5370 2804	-8	-1.9892 3427 7844	-7
	IM	6.0397 3757 4807	-9	1.6720 8485 8263	-8	4.6297 1036 7744	-8	1.2818 3495 7461	-7
5	RE	-9.6979 2978 5035	-9	-2.6998 8922 1296	-8	-7.5231 0247 7931	-8	-2.0981 3657 7549	-7
	IM	-4.4619 5322 6460	-9	-1.2701 6796 3594	-8	-3.6274 4016 3274	-8	-1.0397 0743 5714	-7
6	RE	-1.1921 1839 4023	-9	-3.0394 5376 5771	-9	-7.5937 2810 7503	-9	-1.8414 6393 6518	-8
	IM	-1.0515 3156 9391	-8	-2.9392 3126 0833	-8	-8.2264 2791 0822	-8	-2.3056 1554 1733	-7
7	RE	8.2908 6273 7007	-9	2.3319 6353 7645	-8	6.5710 8398 5364	-8	1.8552 5507 7667	-7
	IM	-6.4076 8576 0321	-9	-1.7616 2089 5329	-8	-4.8388 0927 9783	-8	-1.3274 6105 4719	-7
8	RE	9.6752 5157 5922	-9	2.6827 8644 0488	-8	7.4407 1326 3991	-8	2.0639 3141 2535	-7
	IM	3.7157 9693 0173	-9	1.0674 6927 4209	-8	3.0756 9363 2328	-8	8.8899 0513 6296	-8
9	RE	1.8393 1820 6740	-9	4.7574 1891 1560	-9	1.2140 7566 8308	-8	3.0421 4055 8328	-8
	IM	1.0075 5984 4297	-8	2.8099 2664 9408	-8	7.8426 5771 3512	-8	2.1905 8475 6783	-7
10	RE	-7.5436 6478 0713	-9	-2.1216 7274 7662	-8	-5.9753 8616 8639	-8	-1.6851 9827 9124	-7
	IM	6.7365 6146 9835	-9	1.8436 7923 8353	-8	5.0391 0916 0736	-8	1.3749 3035 3407	-7
11	RE	-9.5573 5041 5508	-9	-2.6414 9645 9644	-8	-7.2994 2746 3985	-8	-2.0164 3622 4036	-7
	IM	-2.8764 8886 2158	-9	-8.3574 5181 3609	-9	-2.4331 6152 5864	-8	-7.0981 8686 9951	-8
12	RE	-2.5145 6163 3049	-9	-6.5886 5326 3064	-9	-1.7118 0542 5654	-8	-4.3999 4854 8018	-8
	IM	-9.5182 5424 1598	-9	-2.6488 9201 3914	-8	-7.3746 8511 1677	-8	-2.0537 9399 6017	-7
13	RE	6.6928 7043 9688	-9	1.8822 1348 3701	-8	5.2981 9486 1551	-8	1.4926 7103 4618	-7
	IM	-7.0306 5478 5465	-9	-1.9194 8887 2551	-8	-5.2333 5551 8814	-8	-1.4244 5919 9848	-7
14	RE	9.3620 7748 5500	-9	2.5815 2554 3062	-8	7.1157 5067 5607	-8	1.9603 8228 6671	-7
	IM	1.9759 5572 1971	-9	5.8547 0526 7377	-9	1.7348 0549 0201	-8	5.1402 4548 5208	-8
15	RE	3.1961 8081 9518	-9	8.4609 8636 8888	-9	2.2279 4914 3557	-8	5.8293 7014 5048	-8
	IM	8.8717 1816 6226	-9	2.4649 2814 5665	-8	6.8495 4159 2813	-8	1.9034 2769 6716	-7
16	RE	-5.7721 9652 4145	-9	-1.6240 4029 6903	-8	-4.5719 4745 0620	-8	-1.2877 0045 2817	-7
	IM	7.2822 0340 8499	-9	1.9861 4758 5719	-8	5.4104 1961 5663	-8	1.4717 3233 4694	-7
17	RE	-9.0964 4161 0442	-9	-2.5045 1372 0322	-8	-6.8926 7454 2790	-8	-1.8958 8606 7390	-7
	IM	-1.0466 4498 2309	-9	-3.2677 5445 2351	-9	-1.0124 2672 0838	-8	-3.1161 0934 8457	-8
18	RE	-3.8593 0385 7119	-9	-1.0295 2012 5127	-8	-2.7370 4819 5864	-8	-7.2481 5257 0219	-8
	IM	-8.1555 0024 1274	-9	-2.2635 2793 2471	-8	-6.2822 6565 6592	-8	-1.7434 1903 8864	-7
19	RE	4.8086 9865 0861	-9	1.3550 3245 1942	-8	3.8193 7972 0074	-8	1.0767 4565 7746	-7
	IM	-7.4784 5733 6494	-9	-2.0393 0081 5634	-8	-5.5553 1850 1790	-8	-1.5115 8298 6707	-7
20	RE	8.7614 8849 4892	-9	2.4101 9378 4500	-8	6.6273 6211 3636	-8	1.8213 9243 9980	-7
	IM	1.1668 5715 0785	-10	6.8022 2811 0293	-10	2.9082 8859 3350	-9	1.0988 9711 1288	-8

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		-12		-11		-10		-9	
0	RE	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0
	IM	-6.8119 6273 5151	-7	-1.9279 2993 1304	-6	-5.4759 8795 3368	-6	-1.5620 3402 2748	-5
1	RE	5.8612 5650 1551	-7	1.6615 9115 3623	-6	4.7284 7931 6392	-6	1.3518 0640 2320	-5
	IM	-3.4509 1823 6456	-7	-9.7101 1745 0070	-7	-2.7388 1605 5176	-6	-7.7461 7067 7491	-6
2	RE	5.9225 6730 8033	-7	1.6684 9468 5898	-6	4.7124 9918 1965	-6	1.3348 6292 0924	-5
	IM	3.2825 1495 7768	-7	9.3873 1930 1083	-7	2.6983 6312 8390	-6	7.8044 4066 2880	-6
3	RE	1.8411 5844 8645	-8	3.4375 5567 2574	-8	3.8795 2371 1166	-8	-8.7640 7242 3821	-8
	IM	6.7198 3089 5045	-7	1.8979 2773 4022	-6	5.3758 1412 9414	-6	1.5276 3519 2165	-5
4	RE	-5.6322 6000 8732	-7	-1.5996 2378 3013	-6	-4.5590 2353 0856	-6	-1.3045 2142 8781	-5
	IM	3.5479 9727 5555	-7	9.8138 7092 0522	-7	2.7111 1247 2080	-6	7.4732 1989 3864	-6
5	RE	-5.8565 9684 8275	-7	-1.6360 6343 6416	-6	-4.5733 3609 2038	-6	-1.2788 6555 8684	-5
	IM	-2.9921 7940 2599	-7	-8.6506 9447 3551	-7	-2.5139 1750 2147	-6	-7.3479 0924 2667	-6
6	RE	-4.2609 7241 6158	-8	-9.0830 4649 0091	-8	-1.6262 9935 5557	-7	-1.5659 9116 7029	-7
	IM	-6.4712 4064 6269	-7	-1.8189 8941 5251	-6	-5.1205 0915 9968	-6	-1.4434 5362 9217	-5
7	RE	5.2490 2103 2694	-7	1.4883 7338 8828	-6	4.2300 1499 6337	-6	1.2049 8255 5388	-5
	IM	-3.6353 7791 1528	-7	-9.9319 0103 9912	-7	-2.7044 1352 7404	-6	-7.3303 0263 1815	-6
8	RE	5.7247 0254 4799	-7	1.5873 8023 7161	-6	4.3987 5713 5146	-6	1.2175 6597 1516	-5
	IM	2.5780 7264 7540	-7	7.5024 6178 4682	-7	2.1911 3359 1608	-6	6.4224 4956 3386	-6
9	RE	7.4283 9088 1978	-8	1.7453 7401 9266	-7	3.8535 0312 8188	-7	7.5817 3210 7174	-7
	IM	6.1228 7489 0032	-7	1.7123 7596 2861	-6	4.7908 5962 6279	-6	1.3405 4991 7469	-5
10	RE	-4.7591 2661 2544	-7	-1.3457 7099 1383	-6	-3.8100 8788 4464	-6	-1.0797 8747 4566	-5
	IM	3.7433 5050 9730	-7	1.0163 2577 9924	-6	2.7495 9464 7269	-6	7.4054 4342 8506	-6
11	RE	-5.5673 4728 7611	-7	-1.5359 1588 5958	-6	-4.2325 2781 0553	-6	-1.1645 7837 9556	-5
	IM	-2.0748 1367 3898	-7	-6.0760 0150 7791	-7	-1.7823 1480 5742	-6	-5.2355 1544 3261	-6
12	RE	-1.1153 4433 9413	-7	-2.7757 2226 7606	-7	-6.7358 4163 8325	-7	-1.5764 9453 1250	-6
	IM	-5.7207 4330 0965	-7	-1.5935 3296 6307	-6	-4.4380 5444 4011	-6	-1.2354 7069 6447	-5
13	RE	4.2086 0975 8667	-7	1.1873 9812 7298	-6	3.3516 7611 9058	-6	9.4631 7851 0755	-6
	IM	-3.8693 6933 1102	-7	-1.0484 9619 2834	-6	-2.8327 7915 0138	-6	-7.6264 5761 5765	-6
14	RE	5.3970 8767 1919	-7	1.4845 1765 8637	-6	4.0786 0074 5085	-6	1.1189 5576 0274	-5
	IM	1.5228 4283 2515	-7	4.5101 8045 0330	-7	1.3350 7476 5165	-6	3.9488 2976 7108	-6
15	RE	1.5135 1806 5728	-7	3.8927 6085 4350	-7	9.8959 6063 0112	-7	2.4790 2674 1754	-6
	IM	5.2890 2551 3309	-7	1.4693 1396 1865	-6	4.0801 4665 6361	-6	1.1323 1728 9638	-5
16	RE	-3.6281 6863 9164	-7	-1.0224 8482 4322	-6	-2.8816 9236 2326	-6	-8.1202 6305 9956	-6
	IM	3.9966 8775 5172	-7	1.0832 4493 3831	-6	2.9293 8018 9184	-6	7.9013 4587 1048	-6
17	RE	-5.2111 9117 0576	-7	-1.4311 8096 0484	-6	-3.9265 3580 4801	-6	-1.0759 6790 0233	-5
	IM	-9.5354 1444 7375	-8	-2.9026 1777 1389	-7	-8.7929 1097 8007	-7	-2.6514 0243 2225	-6
18	RE	-1.9107 6188 3660	-7	-5.0108 4139 1854	-7	-1.3060 8906 1621	-6	-3.3802 9392 7828	-6
	IM	-4.8372 1653 0304	-7	-1.3416 6383 6290	-6	-3.7195 0661 5637	-6	-1.0305 1027 7729	-5
19	RE	3.0357 0293 0109	-7	8.5579 9713 6477	-7	2.4120 4061 4110	-6	6.7955 0486 2957	-6
	IM	-4.1075 3622 4196	-7	-1.1145 0602 1843	-6	-3.0189 4326 8783	-6	-8.1623 3408 5093	-6
20	RE	5.0025 9949 9458	-7	1.3729 9387 4531	-6	3.7650 4107 0601	-6	1.0314 3900 0891	-5
	IM	3.8822 3150 5751	-8	1.3143 3020 2060	-7	4.3195 6648 9672	-7	1.3886 1522 9310	-6

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		-8		-7		-6		-5	
0	RE	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0
	IM	-4.4789 8997 3760	-5	-1.2926 6638 2545	-4	-3.7618 4700 3125	-4	-1.1069 0655 1918	-3
1	RE	3.8863 7061 4029	-5	1.1251 5927 9433	-4	3.2868 4099 8996	-4	9.7163 2956 3820	-4
	IM	-2.1976 1373 6296	-5	-6.2563 0609 1562	-5	-1.7878 2703 5796	-4	-5.1285 0755 8292	-4
2	RE	3.7935 5712 5524	-5	1.0820 7157 4347	-4	3.0989 7351 4344	-4	8.9119 6093 9434	-4
	IM	2.2744 1992 5272	-5	6.6911 6133 0388	-5	1.9923 0096 8494	-4	6.0256 3486 4447	-4
3	RE	-9.3143 6930 0571	-7	-5.0674 4772 2844	-6	-2.3253 3160 9029	-5	-9.9527 8426 6716	-5
	IM	4.3570 6624 6230	-5	1.2478 6269 8620	-4	3.5901 8032 3707	-4	1.0378 0833 3925	-3
4	RE	-3.7496 0872 0138	-5	-1.0832 1992 2008	-4	-3.1467 2858 0951	-4	-9.1943 4839 6645	-4
	IM	2.0525 4575 1075	-5	5.6038 2909 5908	-5	1.5149 0242 4065	-4	4.0276 4783 1929	-4
5	RE	-3.5757 5652 2992	-5	-9.9887 5679 5465	-5	-2.7840 1632 7872	-4	-7.7248 6056 5417	-4
	IM	-2.1616 3153 3695	-5	-6.4045 5340 6296	-5	-1.9120 8960 2178	-4	-5.7530 3513 7216	-4
6	RE	5.4574 1929 4174	-7	4.8011 4245 3086	-6	2.4400 8201 2981	-5	1.0508 2544 3785	-4
	IM	-4.0739 1567 4346	-5	-1.1507 1106 6956	-4	-3.2505 1976 3945	-4	-9.1716 4592 0628	-4
7	RE	3.4403 0869 3842	-5	9.8421 4667 4838	-5	2.8199 7734 9766	-4	8.0851 8480 3256	-4
	IM	-1.9742 8860 1463	-5	-5.2705 5318 2681	-5	-1.3896 8907 6963	-4	-3.6006 6179 0811	-4
8	RE	3.3642 1137 1903	-5	9.2707 5227 1956	-5	2.5448 9982 9111	-4	6.9482 8555 9343	-4
	IM	1.8890 9270 1476	-5	5.5743 6299 2990	-5	1.6491 9770 9059	-4	4.8872 5961 6958	-4
9	RE	1.1240 7468 2304	-6	3.5707 4876 8038	-8	-9.5692 1531 2723	-6	-5.6636 7763 8981	-5
	IM	3.7500 9846 5325	-5	1.0482 4674 5136	-4	2.9257 5534 7661	-4	8.1464 4395 3722	-4
10	RE	-3.0623 6885 4038	-5	-8.6878 9262 5335	-5	-2.4641 3670 8936	-4	-6.9821 5170 3044	-4
	IM	1.9831 4433 3822	-5	5.2725 1193 8045	-5	1.3890 4175 2948	-4	3.6176 3287 2939	-4
11	RE	-3.1978 4421 8595	-5	-8.7579 8981 6580	-5	-2.3905 7949 2987	-4	-6.4983 6547 6871	-4
	IM	-1.5394 7995 0184	-5	-4.5289 7348 4812	-5	-1.3321 1068 8089	-4	-3.9140 5296 1545	-4
12	RE	-3.4899 3099 6300	-6	-7.0188 1175 8894	-6	-1.1491 6458 1093	-5	-8.1647 6710 9088	-6
	IM	-3.4366 6725 3979	-5	-9.5484 6803 0607	-5	-2.6485 9324 6952	-4	-7.3307 2550 5440	-4
13	RE	2.6717 4998 0227	-5	7.5402 1235 7339	-5	2.1262 5487 9812	-4	5.9879 4149 4773	-4
	IM	-2.0445 6623 0492	-5	-5.4539 0935 8166	-5	-1.4463 0226 9035	-4	-3.8091 5395 9665	-4
14	RE	3.0644 2880 2578	-5	8.3746 0091 1911	-5	2.2828 9814 0943	-4	6.2049 5060 3209	-4
	IM	1.1666 2627 5443	-5	3.4412 4115 5513	-5	1.0129 9899 3354	-4	2.9742 5695 3429	-4
15	RE	6.0941 1381 7145	-6	1.4611 6257 5036	-5	3.3847 8218 7797	-5	7.4542 5012 8980	-5
	IM	3.1396 9001 3624	-5	8.6958 7691 3776	-5	2.4050 1639 6100	-4	6.6399 1223 9558	-4
16	RE	-2.2872 8450 3693	-5	-6.4384 2440 6693	-5	-1.8105 7831 6233	-4	-5.0850 1469 6794	-4
	IM	2.1249 2276 5013	-5	5.6954 8954 7103	-5	1.5208 4660 7136	-4	4.0441 0618 1308	-4
17	RE	-2.9442 4899 1467	-5	-8.0434 2307 0256	-5	-2.1933 1676 0632	-4	-5.9684 1538 5298	-4
	IM	-7.9593 2158 1638	-6	-2.3787 5658 1253	-5	-7.0775 1164 3460	-5	-2.0961 6599 7320	-4
18	RE	-8.6761 1345 0446	-6	-2.2051 2514 1748	-5	-5.5393 7438 7950	-5	-1.3719 9719 0026	-4
	IM	-2.8527 9182 8010	-5	-7.8896 6288 9481	-5	-2.1793 8161 8231	-4	-6.0118 5655 7027	-4
19	RE	1.9133 7952 7826	-5	5.3831 1970 4940	-5	1.5129 5758 0966	-4	4.2470 0324 7014	-4
	IM	-2.2022 8077 4047	-5	-5.9284 3746 6344	-5	-1.5919 4398 5333	-4	-4.2633 3082 6016	-4
20	RE	2.8224 8883 6434	-5	7.7139 4794 6711	-5	2.1053 1993 5228	-4	5.7371 9312 0454	-4
	IM	4.3874 2498 7607	-6	1.3668 0482 3905	-5	4.2075 2787 2666	-5	1.2818 8583 7471	-4

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		-4		-3		-2		-1	
0	RE	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0	0.0000 0000 0000	0
	IM	-3.3076 5812 5692	-3	-1.0115 7836 5252	-2	-3.2173 5451 4689	-2	-1.1122 7335 9805	-1
1	RE	2.9198 0620 9576	-3	8.9866 4359 1980	-3	2.8703 6042 3974	-2	9.7080 2175 7076	-2
	IM	-1.4753 6801 0522	-3	-4.2375 4185 8084	-3	-1.1924 1037 5461	-2	-2.9721 3004 7234	-2
2	RE	2.5715 2067 1404	-3	7.4195 8689 8416	-3	2.1156 0189 4931	-2	5.7426 1745 0131	-2
	IM	1.8606 6231 4800	-3	5.9072 8068 8627	-3	1.9432 3412 2180	-2	6.6166 9985 9822	-2
3	RE	-4.1338 7304 6730	-4	-1.6984 0098 0712	-3	-6.9429 3661 8955	-3	-2.7912 2376 1406	-2
	IM	3.0124 9747 6542	-3	8.7591 2566 0126	-3	2.5328 4994 1152	-2	7.1647 1903 1881	-2
4	RE	-2.7009 3589 8869	-3	-7.9613 1951 2395	-3	-2.3430 5444 6209	-2	-6.8198 9120 8879	-2
	IM	1.0403 2096 4700	-3	2.5500 6939 6591	-3	5.6480 7916 8862	-3	9.9719 4722 5812	-3
5	RE	-2.1262 9079 3662	-3	-5.7737 4953 6521	-3	-1.5341 6415 1800	-2	-3.9470 4555 8674	-2
	IM	-1.7432 4271 7985	-3	-5.3080 7427 9728	-3	-1.6167 5562 7844	-2	-4.8889 9297 6907	-2
6	RE	4.1690 6618 6193	-4	1.5700 7008 3796	-3	5.6762 7726 8536	-3	1.9751 4184 2189	-2
	IM	-2.5800 0209 2319	-3	-7.2151 0783 9604	-3	-1.9982 8374 3056	-2	-5.4565 1197 7050	-2
7	RE	2.3164 6542 5134	-3	6.6188 7545 5656	-3	1.8811 3877 4939	-2	5.3016 3941 7538	-2
	IM	-9.0999 0265 8266	-4	-2.2188 2378 0986	-3	-5.1321 5034 2405	-3	-1.0943 3679 9819	-2
8	RE	1.8831 8040 3048	-3	5.0548 7465 7917	-3	1.3403 9034 7705	-2	3.5025 0648 4067	-2
	IM	1.4485 8467 2073	-3	4.2859 1959 1959	-3	1.2626 5224 8196	-2	3.6935 9062 7783	-2
9	RE	-2.4958 7770 3940	-4	-9.7129 3158 6704	-4	-3.5144 6854 2976	-3	-1.2081 9852 8608	-2
	IM	2.2602 7757 9680	-3	6.2408 9383 3339	-3	1.7124 1752 3858	-2	4.6629 9599 4591	-2
10	RE	-1.9746 5643 3805	-3	-5.5681 1201 8564	-3	-1.5636 3063 1738	-2	-4.3678 7393 3800	-2
	IM	9.2872 7137 6394	-4	2.3419 1531 0674	-3	5.7755 7274 3448	-3	1.3855 2276 2233	-2
11	RE	-1.7576 2397 1667	-3	-4.7258 0440 4034	-3	-1.2620 5857 3457	-2	-3.3451 9535 0226	-2
	IM	-1.1476 7731 9301	-3	-3.3544 6488 5[illegible]91	-3	-9.7613 4278 0117	-3	-2.8246 1550 9928	-2
12	RE	4.7043 6381 9671	-5	3.3241 2387 8320	-4	1.4969 0072 2934	-3	5.7549 4898 4321	-3
	IM	-2.0233 5012 6089	-3	-5.5657 0059 4621	-3	-1.5248 7461 3172	-2	-4.1589 7340 1484	-2
13	RE	1.6831 9107 3520	-3	4.7198 9317 3518	-3	1.3195 4072 9981	-2	3.6759 6373 3175	-2
	IM	-9.9529 8523 9219	-4	-2.5771 6522 3583	-3	-6.6052 0114 7867	-3	-1.6736 6145 3259	-2
14	RE	1.6808 9308 1615	-3	4.5365 0344 7127	-3	1.2193 5961 9370	-2	3.2632 8480 3032	-2
	IM	8.7050 1636 2566	-4	2.5381 6287 0147	-3	7.3683 4038 2282	-3	2.1285 3896 5017	-2
15	RE	1.5123 8296 6524	-4	2.6173 9177 3240	-4	2.8307 7104 4127	-4	-4.4168 0592 7442	-4
	IM	1.8293 8122 4365	-3	5.0281 0571 7868	-3	1.3782 6949 3234	-2	3.7668 9606 1989	-2
16	RE	-1.4257 9507 1805	-3	-3.9899 1945 9921	-3	-1.1139 6409 3197	-2	-3.1020 5244 0892	-2
	IM	1.0704 3432 0063	-3	2.8191 8246 2509	-3	7.3850 3203 5373	-3	1.9235 7960 4644	-2
17	RE	-1.6203 9609 9093	-3	-4.3883 7232 4090	-3	-1.1853 1747 1443	-2	-3.1927 2421 3865	-2
	IM	-6.1791 0730 1987	-4	-1.8126 4210 5044	-3	-5.2907 2281 5294	-3	-1.5362 8633 3405	-2
18	RE	-3.3396 5995 2960	-4	-7.9531 4219 8398	-4	-1.8405 3464 9210	-3	-4.0949 2961 1425	-3
	IM	-1.6557 6737 1333	-3	-4.5522 3190 1533	-3	-1.2491 3765 7139	-2	-3.4205 4003 6581	-2
19	RE	1.1904 3160 6740	-3	3.3311 7705 6115	-3	9.3040 8196 4855	-3	2.5932 9574 4782	-2
	IM	-1.1384 7536 9903	-3	-3.0309 6073 4752	-3	-8.0437 7707 6305	-3	-2.1277 4224 5497	-2
20	RE	1.5608 7333 0075	-3	4.2391 1704 4700	-3	1.1491 6763 6052	-2	3.1092 9653 2631	-2
	IM	3.8696 0752 9519	-4	1.1583 6926 6485	-3	3.4408 8651 9616	-3	1.0147 4856 6834	-2

COMPLEX FRESNEL INTEGRAL TABLE

Y		X = 0		1		2		3	
0	RE	0.0000 0000 0000	0	1.1670 2724 5891	0	2.6680 0051 4199	0	5.8349 9816 5483	0
	IM	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1
1	RE	3.3527 3009 1524	-1	8.9881 0821 2496	-1	1.9353 5154 1318	0	4.0348 3551 4576	0
	IM	-2.1733 4841 5936	-2	2.5775 1280 0297	-1	1.1485 4842 2256	0	3.3649 2253 4151	0
2	RE	1.3467 0939 5986	-1	2.3678 1740 5965	-1	2.6714 7889 8607	-1	-4.1843 0885 7251	-3
	IM	2.2355 2715 1694	-1	6.8455 1536 3876	-1	1.8495 8217 5631	0	4.6410 0186 5410	0
3	RE	-1.0653 6025 8436	-1	-3.6973 1351 2385	-1	-1.1511 6478 2435	0	-3.2889 9731 6536	0
	IM	1.9283 1802 6650	-1	4.8194 1044 6003	-1	1.1222 5178 3290	0	2.5032 9738 9581	0
4	RE	-1.9369 4762 0583	-1	-5.3049 5229 4960	-1	-1.3976 4566 6881	0	-3.5702 8375 1893	0
	IM	7.2914 8149 8866	-3	-4.1810 3482 5948	-2	-2.7271 3016 5011	-1	-1.0865 7108 5629	0
5	RE	-9.7216 4852 3014	-2	-2.2723 3888 2487	-1	-5.0231 0442 8147	-1	-1.0513 6030 1427	0
	IM	-1.4538 2482 4174	-1	-4.2148 4822 8071	-1	-1.1864 8611 0730	0	-3.2486 7702 7550	0
6	RE	6.6058 9697 8309	-2	2.1197 3162 3952	-1	6.5282 5838 0112	-1	1.9363 5553 3898	0
	IM	-1.4628 1851 4916	-1	-3.8405 3167 7035	-1	-9.8775 6852 5513	-1	-2.4965 5265 4064	0
7	RE	1.4772 9871 0093	-1	4.0612 7401 2159	-1	1.1007 1158 9759	0	2.9435 6047 4079	0
	IM	-2.0286 5152 2258	-2	-2.7317 0658 4625	-2	2.0852 4613 3508	-3	2.0144 1004 1611	-1
8	RE	9.0008 7743 8167	-2	2.2723 6831 6978	-1	5.6365 7915 6131	-1	1.3755 6019 5050	0
	IM	1.0699 2939 6973	-1	3.0623 6521 7334	-1	8.6502 1253 8278	-1	2.4112 0313 5275	0
9	RE	-3.9887 6219 6961	-2	-1.2724 1932 3960	-1	-3.9388 3900 1988	-1	-1.1874 5670 7698	0
	IM	1.2587 7436 6365	-1	3.3667 1475 1916	-1	8.9220 3092 3198	-1	2.3443 6563 6012	0
10	RE	-1.2124 9230 5957	-1	-3.3423 2243 1084	-1	-9.1461 0311 9584	-1	-2.4847 8094 5247	0
	IM	3.2102 7976 2719	-2	7.1110 5589 0886	-2	1.4805 9136 7843	-1	2.8021 6771 2765	-1
11	RE	-8.7960 1710 0870	-2	-2.2940 0298 4341	-1	-5.9350 3244 8718	-1	-1.5240 7952 2313	0
	IM	-8.1191 2659 7952	-2	-2.3163 3114 7715	-1	-6.5556 6326 2966	-1	-1.8403 5136 4129	0
12	RE	2.0326 7275 3168	-2	6.7949 2013 2166	-2	2.1825 6744 5264	-1	6.7969 2348 0249	-1
	IM	-1.1287 6622 7216	-1	-3.0478 4748 5964	-1	-8.1874 8098 1953	-1	-2.1885 9351 6862	0
13	RE	1.0199 4984 4423	-1	2.8177 3164 3449	-1	7.7491 3049 4352	-1	2.1214 3228 3028	0
	IM	-4.1876 1840 9726	-2	-1.0333 7113 6098	-1	-2.5117 4257 7136	-1	-6.0045 4931 3521	-1
14	RE	8.6939 8658 3485	-2	2.3057 1788 4693	-1	6.0877 6648 4487	-1	1.6005 6834 6169	0
	IM	6.1157 9345 5473	-2	1.7471 5562 6563	-1	4.9616 6947 2101	-1	1.4006 1357 3492	0
15	RE	-4.5730 0869 9997	-3	-2.1673 2327 5922	-2	-8.3837 2181 4581	-2	-2.9401 7319 2465	-1
	IM	1.0262 9003 5344	-1	2.7870 4861 3140	-1	7.5438 9993 6705	-1	2.0354 1216 8333	0
16	RE	-8.6136 8090 5979	-2	-2.3845 5367 3285	-1	-6.5803 9328 2435	-1	-1.8101 0524 2983	0
	IM	4.9806 6760 8657	-2	1.2817 6560 8776	-1	3.2781 7656 4080	-1	8.3320 4521 2753	-1
17	RE	-8.5753 5242 0567	-2	-2.2966 7481 8322	-1	-6.1337 1184 6686	-1	-1.6336 8748 2435	0
	IM	-4.4374 7484 8550	-2	-1.2749 1054 7921	-1	-3.6433 6652 5456	-1	-1.0356 9757 6659	0
18	RE	-8.5928 9015 0141	-3	-1.6343 1363 9393	-2	-2.5258 7965 1813	-2	-1.6882 0127 7814	-2
	IM	-9.3460 7798 5758	-2	-2.5479 0528 5738	-1	-6.9301 6799 4130	-1	-1.8806 9144 2830	0
19	RE	7.2121 6384 1379	-2	2.0010 6523 8646	-1	5.5386 3714 0229	-1	1.5292 2826 5369	0
	IM	-5.6095 9189 3631	-2	-1.4739 7560 8276	-1	-3.8602 0179 1635	-1	-1.0076 8429 8947	0
20	RE	8.3964 1171 2365	-2	2.2629 3910 6782	-1	6.0870 6008 0265	-1	1.6342 5250 6371	0
	IM	2.9723 0573 5092	-2	8.6503 2734 8517	-2	2.5021 7690 0936	-1	7.1958 9493 7074	-1

COMPLEX FRESNEL INTEGRAL TABLE

Y		X = 4		X = 5		X = 6		X = 7	
0	RE	1.3127 2976 7873	1	3.0637 2608 1069	1	7.3740 0002 1904	1	1.8160 8779 6218	2
	IM	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1
1	RE	8.6870 4804 2150	0	1.9551 7904 4409	1	4.5760 4347 9457	1	1.1035 7952 3425	2
	IM	8.7984 9514 3582	0	2.2266 5088 7052	1	5.6052 7163 8605	1	1.4166 6599 8575	2
2	RE	-1.1756 7252 1223	0	-4.8728 0380 2912	0	-1.5484 5617 0345	1	-4.4775 6476 7799	1
	IM	1.1343 3936 3146	1	2.7682 6650 8202	1	6.8121 1642 4829	1	1.6946 8695 8750	2
3	RE	-8.9057 8607 7804	0	-2.3432 4676 5160	1	-6.0845 5467 7222	1	-1.5726 4599 8880	2
	IM	5.5104 9411 5124	0	1.2214 4217 8230	1	2.7540 6949 4949	1	6.3377 8855 9923	1
4	RE	-8.9527 4903 9712	0	-2.2281 0306 0328	1	-5.5447 4955 0395	1	-1.3854 8501 6408	2
	IM	-3.6017 2141 5068	0	-1.0861 5002 8347	1	-3.1055 5010 2125	1	-8.6086 6603 9688	1
5	RE	-2.0870 9451 8257	0	-3.9149 1209 4069	0	-6.8164 3171 7065	0	-1.0436 3059 2788	1
	IM	-8.7014 2901 1088	0	-2.2955 4225 7477	1	-6.0008 0432 5723	1	-1.5614 1079 8556	2
6	RE	5.5640 3885 7468	0	1.5594 0820 7981	1	4.2903 1329 3709	1	1.1649 8726 7210	2
	IM	-6.2318 6777 0426	0	-1.5445 4236 3191	1	-3.8185 8033 5108	1	-9.4500 1406 6974	1
7	RE	7.7835 0736 9491	0	2.0406 5870 5356	1	5.3194 1068 4465	1	1.3819 9175 2024	2
	IM	1.0198 6965 7476	0	3.8534 6248 8725	0	1.2844 3531 1212	1	3.9924 7029 1463	1
8	RE	3.3102 5647 9490	0	7.8770 8298 7028	0	1.8587 1505 6360	1	4.3601 2151 9231	1
	IM	6.6388 8272 1386	0	1.8085 6432 8480	1	4.8844 3083 1643	1	1.3103 8438 2672	2
9	RE	-3.4984 3649 9643	0	-1.0106 6316 2785	1	-2.8722 8136 0393	1	-8.0544 8340 2522	1
	IM	6.1154 1918 7906	0	1.5861 3659 7232	1	4.0971 6287 8502	1	1.0556 7079 1881	2
10	RE	-6.7053 6336 3091	0	-1.7988 1444 3916	1	-4.8017 8598 3360	1	-1.2767 8011 9002	2
	IM	4.4220 9202 2295	-1	3.9184 8721 9897	-1	-9.3598 8409 0070	-1	-7.3778 6143 3257	0
11	RE	-3.8879 0133 0550	0	-9.8629 7267 3913	0	-2.4911 2403 8999	1	-6.2717 9534 4635	1
	IM	-5.1256 7808 6787	0	-1.4170 8565 6095	1	-3.8918 3460 4614	1	-1.0626 6463 4575	2
12	RE	2.0644 9463 7037	0	6.1428 6166 0082	0	1.7966 8383 6880	1	5.1800 7262 9990	1
	IM	-5.8238 6706 7133	0	-1.5435 7602 0512	1	-4.0775 0077 3739	1	-1.0742 4787 8918	2
13	RE	5.7821 2416 0843	0	1.5694 4651 6641	1	4.2439 5537 5035	1	1.1438 0969 8185	2
	IM	-1.4091 4277 2975	0	-3.2378 2511 0689	0	-7.2549 9464 8171	0	-1.5750 2718 4263	1
14	RE	4.1918 6257 5412	0	1.0940 8320 6238	1	2.8472 5587 8177	1	7.3921 7101 2668	1
	IM	3.9304 8324 0640	0	1.0967 6340 2460	1	3.0441 7794 3407	1	8.4081 9876 9772	1
15	RE	-9.7186 7408 2356	-1	-3.0856 2344 6917	0	-9.5116 6791 7940	0	-2.8662 7187 6717	1
	IM	5.4749 3493 2097	0	1.4684 9538 7285	1	3.9287 5244 1642	1	1.0487 2795 7909	2
16	RE	-4.9633 7143 2647	0	-1.3567 9702 8562	1	-3.6981 8254 0946	1	-1.0052 8149 9069	2
	IM	2.1046 9381 5227	0	5.2843 2106 3648	0	1.3188 9552 0070	1	3.2727 4768 4167	1
17	RE	-4.3401 6143 6745	0	-1.1503 3488 1219	1	-3.0424 9955 6426	1	-8.0323 3596 1467	1
	IM	-2.9290 4665 3648	0	-8.2426 3471 5796	0	-2.3086 5412 3839	1	-6.4376 9010 6408	1
18	RE	9.2441 7917 4288	-2	6.1688 1392 8571	-1	2.6331 5385 6246	0	9.6346 4195 6787	0
	IM	-5.0924 8836 7635	0	-1.3760 1680 1831	1	-3.7106 9843 5032	1	-9.9883 6242 2011	1
19	RE	4.2118 1404 1248	0	1.1572 0540 7936	1	3.1719 6667 4207	1	8.6750 0015 3038	1
	IM	-2.6223 2666 0269	0	-6.8040 3779 6829	0	-1.7605 4827 2623	1	-4.5438 5602 2947	1
20	RE	4.3796 7031 3979	0	1.1717 0825 9836	1	3.1297 3829 2082	1	8.3477 4354 0506	1
	IM	2.0580 9426 1209	0	5.8558 7635 9647	0	1.6580 5452 4918	1	4.6732 7937 8470	1

COMPLEX FRESNEL INTEGRAL TABLE

		X							
Y		8		9		10		11	
0	RE	4.5475 9370 6091	2	1.1525 8025 0939	3	2.9476 0027 5872	3	7.5904 2447 9268	3
	IM	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1
1	RE	2.7201 1164 7563	2	6.8111 3877 6713	2	1.7254 0951 7906	3	4.4093 3508 8763	3
	IM	3.6037 8502 7279	2	9.2278 4464 5860	2	2.3767 6889 9043	3	6.1525 3948 6959	3
2	RE	-1.2414 4841 2440	2	-3.3719 4881 8795	2	-9.0626 5840 3491	2	-2.4223 9372 6342	3
	IM	4.2604 1791 4075	2	1.0808 6785 4792	3	2.7631 3633 6770	3	7.1083 6725 6152	3
3	RE	-4.0637 5467 9903	2	-1.0519 7927 3095	3	-2.7304 0955 4154	3	-7.1069 5257 8180	3
	IM	1.4878 5210 8625	2	3.5556 5516 4020	2	8.6278 5871 5954	2	2.1205 6563 4384	3
4	RE	-3.4825 4401 5860	2	-8.8099 7967 0417	2	-2.2425 4122 3101	3	-5.7407 0227 4434	3
	IM	-2.3432 7287 1716	2	-6.3103 7928 2139	2	-1.6887 8495 2908	3	-4.5034 7893 1946	3
5	RE	-1.1489 5603 1219	1	3.7979 1436 1624	0	8.3068 2880 5502	1	3.7743 9545 4745	2
	IM	-4.0561 6475 0576	2	-1.0539 2163 6592	3	-2.7418 9572 3162	3	-7.1462 1253 4065	3
6	RE	3.1352 3285 0514	2	8.3881 2763 0989	2	2.2358 7606 5501	3	5.9465 7570 0574	3
	IM	-2.3462 8910 2275	2	-5.8521 1904 0585	2	-1.4671 8143 1516	3	-3.6978 4799 8345	3
7	RE	3.5852 5183 2214	2	9.3003 6739 7405	2	2.4145 9793 5738	3	6.2777 0509 7627	3
	IM	1.1880 0476 0984	2	3.4341 0254 7976	2	9.7308 1870 3736	2	2.7188 2574 3659	3
8	RE	1.0188 4806 8282	2	2.3751 8714 7017	2	5.5295 7710 7243	2	1.2862 4181 8040	3
	IM	3.4983 5275 5856	2	9.3079 7194 5311	2	2.4710 6382 1719	3	6.5514 6044 8796	3
9	RE	-2.2345 4997 5991	2	-6.1470 3738 3089	2	-1.6798 7714 6406	3	-4.5675 3804 8098	3
	IM	2.7168 0623 2310	2	6.9910 3293 6295	2	1.8002 3396 2478	3	4.6416 3548 7621	3
10	RE	-3.3849 4210 2509	2	-8.9554 4241 5070	2	-2.3661 5694 5965	3	-6.2471 1700 5730	3
	IM	-3.1516 6568 5194	1	-1.1244 5109 9569	2	-3.6745 3261 5090	2	-1.1400 9782 7751	3
11	RE	-1.5757 2572 9158	2	-3.9544 9198 7151	2	-9.9216 8043 4761	2	-2.4903 4056 4431	3
	IM	-2.8873 9481 3067	2	-7.8136 7666 4955	2	-2.1075 7915 5145	3	-5.6700 9809 8530	3
12	RE	1.4756 6001 9162	2	4.1618 8050 7399	2	1.1640 7363 6137	3	3.2335 4995 1501	3
	IM	-2.8245 4561 3742	2	-7.4164 1122 6945	2	-1.9457 0041 2967	3	-5.1026 3782 0512	3
13	RE	3.0739 8859 5217	2	8.2418 1574 0885	2	2.2055 2508 7531	3	5.8931 6660 7492	3
	IM	-3.2757 4125 0546	1	-6.3875 3527 7224	1	-1.1125 8831 9065	2	-1.4910 8247 8728	2
14	RE	1.9156 8621 8120	2	4.9580 5221 9306	2	1.2821 5804 8503	3	3.3143 7742 0450	3
	IM	2.3121 6489 1325	2	6.3333 4642 3156	2	1.7288 6161 2638	3	4.7054 8181 2147	3
15	RE	-8.4832 8773 2304	1	-2.4744 6692 3834	2	-7.1317 8187 5203	2	-2.0351 5831 8950	3
	IM	2.7941 0488 4210	2	7.4325 9176 4733	2	1.9746 7684 3295	3	5.2413 1705 7178	3
16	RE	-2.7259 4812 1097	2	-7.3754 8800 5381	2	-1.9916 9383 6559	3	-5.3694 1000 4253	3
	IM	8.0750 6102 3351	1	1.9812 4629 0537	2	4.8337 4984 2827	2	1.1725 4357 4391	3
17	RE	-2.1172 9459 9954	2	-5.5740 7216 1471	2	-1.4660 0740 2566	3	-3.8528 8224 3560	3
	IM	-1.7877 9747 6030	2	-4.9461 8401 0904	2	-1.3637 5224 2201	3	-3.7485 3949 2532	3
18	RE	3.2546 8695 8397	1	1.0464 8748 4869	2	3.2530 8610 1294	2	9.8666 2095 5420	2
	IM	-2.6842 0780 7611	2	-7.2028 1638 8408	2	-1.9303 4797 6249	3	-5.1677 0200 0374	3
19	RE	2.3674 9770 1278	2	6.4484 1793 1453	2	1.7531 9307 8656	3	4.7587 3195 8632	3
	IM	-1.1700 3147 5109	2	-3.0065 6878 9620	2	-7.7116 9185 8962	2	-1.9748 5245 0352	3
20	RE	2.2236 6817 5675	2	5.9167 1796 7301	2	1.5727 9739 9696	3	4.1774 9278 6917	3
	IM	1.3115 8801 2546	2	3.6665 9032 0339	2	1.0212 9545 2680	3	2.8352 8086 8761	3

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		12		13		14		15	
0	RE	1.9653 9619 1380	4	5.1112 3401 0358	4	1.3341 6488 6584	5	3.4933 0155 5588	5
	IM	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1
1	RE	1.1365 3072 6472	4	2.9351 1875 9041	4	7.6272 7170 6175	4	1.9894 1031 6858	5
	IM	1.5994 4654 9641	4	4.1730 5959 6604	4	1.0921 3993 0630	5	2.8658 8666 7930	5
2	RE	-6.4556 5040 5965	3	-1.7186 2793 5339	4	-4.5722 1447 9804	4	-1.2163 2686 1553	5
	IM	1.8382 6333 5890	4	4.7746 7379 2829	4	1.2447 5286 1139	5	3.2553 0474 5280	5
3	RE	-1.8550 0669 7010	4	-4.0543 0355 4804	4	-1.2733 6445 3869	5	-3.3473 7475 9890	5
	IM	5.2680 9715 7642	3	1.3205 9622 2424	4	3.3354 2686 4127	4	8.4790 1299 5862	4
4	RE	-1.4770 0324 2923	4	-3.8170 5861 4295	4	-9.9030 2154 9657	4	-2.5780 5607 9139	5
	IM	-1.1986 3299 9687	4	-3.1873 0732 3176	4	-8.4728 0258 9159	4	-2.2524 7590 3494	5
5	RE	1.3437 1385 4323	3	4.3219 3392 0603	3	1.3165 1481 6371	4	3.8797 3538 5874	4
	IM	-1.8662 9350 5959	4	-4.8840 9876 0534	4	-1.2807 4909 0857	5	-3.3649 1984 4371	5
6	RE	1.5796 5805 2766	4	4.1999 9577 0189	4	1.1134 1856 4803	5	2.9565 0554 9675	5
	IM	-9.3679 4924 8197	3	-2.3847 4407 9625	4	-6.0979 4720 9502	4	-1.5656 8898 3451	5
7	RE	1.6349 5931 3836	4	4.2660 6648 9812	4	1.1152 6868 7837	5	2.9211 1957 1536	5
	IM	7.5202 8951 0143	3	2.0649 2316 1491	4	5.6394 0247 1921	4	1.5340 0697 8099	5
8	RE	2.9898 9032 1301	3	6.9441 1979 1931	3	1.6107 1137 0581	4	3.7287 0277 6629	4
	IM	1.7358 1265 5083	4	4.5981 4362 6365	4	1.2182 0403 9377	5	3.2285 8807 5586	5
9	RE	-1.2370 9245 2783	4	-3.3407 7758 3069	4	-9.0019 7029 0468	4	-2.4216 9367 3249	5
	IM	1.1987 6049 0042	4	3.1017 8796 0368	4	8.0419 2922 2931	4	2.0892 5870 6582	5
10	RE	-1.6489 1119 6590	4	-4.3526 0177 6302	4	-1.1493 3405 5716	5	-3.0364 6522 2919	5
	IM	-3.4194 5799 8321	3	-1.0016 7014 1557	4	-2.8844 0170 2092	4	-8.2002 4336 7469	4
11	RE	-6.2566 3439 8259	3	-1.5739 9463 5704	4	-3.9661 5124 1558	4	-1.0012 0306 1034	5
	IM	-1.5224 0659 4504	4	-4.0814 7214 2593	4	-1.0930 0748 3268	5	-2.9247 5747 7155	5
12	RE	8.9311 7475 1683	3	2.4552 9330 7453	4	6.7239 7944 1267	4	1.8355 9849 2319	5
	IM	-1.3381 7579 8819	4	-3.5104 2791 3327	4	-9.2136 9563 9880	4	-2.4199 5453 0435	5
13	RE	1.5728 6500 2321	4	4.1944 6526 7293	4	1.1179 4156 9805	5	2.9786 1229 3687	5
	IM	-3.0862 7754 6883	1	8.2590 9777 2034	2	4.4467 2568 8014	3	1.7399 0503 6733	4
14	RE	8.5674 7461 9191	3	2.2152 8040 5473	4	5.7311 1797 2377	4	1.4837 0796 6584	5
	IM	1.2774 8062 3856	4	3.4608 4794 1401	4	9.3592 5360 2063	4	2.5273 4160 1552	5
15	RE	-5.7595 9035 6124	3	-1.6186 6139 7882	4	-4.5223 8694 2268	4	-1.2572 4866 1328	5
	IM	1.3902 4433 3025	4	3.6859 6809 4156	4	9.7703 6183 8900	4	2.5896 6285 6810	5
16	RE	-1.4454 7642 3789	4	-3.8866 6056 5051	4	-1.0440 3502 9701	5	-2.8022 6002 5011	5
	IM	2.8272 0192 2920	3	6.7728 5742 4256	3	1.6109 2771 8732	4	3.8004 6088 8553	4
17	RE	-1.0121 0590 6587	4	-2.6579 7536 1962	4	-6.9798 0982 0034	4	-1.8330 5477 6496	5
	IM	-1.0275 2725 2270	4	-2.8097 3263 1173	4	-7.6666 1267 1339	4	-2.0879 7436 2853	5
18	RE	2.9369 7968 3844	3	8.6146 3636 4227	3	2.4970 6461 5830	4	7.1682 7487 2542	4
	IM	-1.3821 8501 1267	4	-3.6941 5536 9758	4	-9.8676 0779 8031	4	-2.6346 1597 2119	5
19	RE	1.2897 6314 5763	4	3.4910 5526 4676	4	9.4384 2348 6301	4	2.5491 9002 2604	5
	IM	-5.0503 6292 9256	3	-1.2900 4001 9765	4	-3.2919 8750 5598	4	-8.3938 3902 5141	4
20	RE	1.1088 6084 8843	4	2.9418 4931 8751	4	7.8019 7950 7022	4	2.0686 3550 2145	5
	IM	7.8473 5854 2932	3	2.1659 8234 3767	4	5.9635 5132 3366	4	1.6382 5299 0240	5

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		16		17		18		19	
0	RE	9.1708 9020 5163	5	2.4131 3607 9793	6	6.3624 2406 2043	6	1.6804 7386 0388	7
	IM	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1	-7.0710 6781 1865	-1
1	RE	5.2052 7903 0184	5	1.3656 3444 1218	6	3.5912 1063 2685	6	9.4631 8759 6770	6
	IM	7.5378 1618 4661	5	1.9866 1882 2478	6	5.2452 2137 8123	6	1.3871 0024 3014	7
2	RE	-3.2364 8756 0725	5	-8.6152 4729 7804	5	-2.2944 1146 5117	6	-6.1137 1784 4431	6
	IM	8.5365 2519 3631	5	2.2438 7598 1012	6	5.9104 3513 3595	6	1.5596 9219 7799	7
3	RE	-8.8165 4035 1335	5	-2.3262 2812 6278	6	-6.1474 3181 4312	6	-1.6268 8958 2446	7
	IM	2.1674 0522 4843	5	5.5668 6969 1133	5	1.4357 9052 0266	6	3.7167 1031 1966	6
4	RE	-6.7316 7620 1151	5	-1.7624 1224 6664	6	-4.6250 3340 8156	6	-1.2162 8117 1722	7
	IM	-5.9099 5197 3140	5	-1.5935 9015 7315	6	-4.2418 4198 7665	6	-1.1297 3077 4487	7
5	RE	1.1187 4431 9144	5	3.1776 9833 6983	5	8.9285 3674 2966	5	2.4885 8585 5357	6
	IM	-8.8565 0434 6400	5	-2.3349 1097 9953	6	-6.1651 4517 1623	6	-1.6301 5520 8776	7
6	RE	7.8536 1040 5171	5	2.0872 7561 4436	6	5.5505 8459 7497	6	1.4769 3358 5772	7
	IM	-4.0350 3078 2372	5	-1.0434 1603 5811	6	-2.7064 4984 6534	6	-7.0396 3515 2705	6
7	RE	7.6648 9637 8566	5	2.0146 9887 0741	6	5.3041 5775 1168	6	1.3985 5535 4256	7
	IM	4.1603 1957 9298	5	1.1257 8397 4751	6	3.0412 5946 0080	6	8.2054 6272 2298	6
8	RE	8.6065 3752 9066	4	1.9783 1919 8878	5	4.5213 8394 4819	5	1.0252 9701 8140	6
	IM	8.5609 9962 4585	5	2.2714 1208 0460	6	6.0304 6142 4241	6	1.6021 3853 5532	7
9	RE	-6.5070 3190 5978	5	-1.7469 2934 7110	6	-4.6871 5255 5798	6	-1.2571 0260 2615	7
	IM	5.4387 5612 0550	5	1.4185 9452 0559	6	3.7071 0228 0647	6	9.7048 5964 1574	6
10	RE	-8.0272 8631 5243	5	-2.1236 4581 7369	6	-5.6224 8699 9541	6	-1.4897 6412 5672	7
	IM	-2.3085 8745 9894	5	-6.4499 6797 5741	5	-1.7912 5538 9010	6	-4.9507 6201 7519	6
11	RE	-2.5322 9182 9544	5	-6.4175 8344 1233	5	-1.6296 8866 4024	6	-4.1467 5877 3256	6
	IM	-7.8221 9779 5100	5	-2.0913 5666 4376	6	-5.5905 7809 7032	6	-1.4944 0413 5464	7
12	RE	4.9981 0175 1268	5	1.3580 4048 8684	6	3.6835 6699 2320	6	9.9772 5049 2199	6
	IM	-6.3610 8832 5193	5	-1.6735 5793 8719	6	-4.4071 3114 7090	6	-1.1616 8271 2992	7
13	RE	7.9348 4571 1576	5	2.1137 5432 3234	6	5.6313 2853 1674	6	1.5005 3276 9889	7
	IM	6.0080 4317 9599	4	1.9403 6224 9043	5	6.0117 1662 8420	5	1.8109 2958 7277	6
14	RE	3.8449 7285 0316	5	9.9736 3637 8205	5	2.5899 3003 3047	6	6.7331 8102 1363	6
	IM	6.8165 7458 9045	5	1.8367 3644 2340	6	4.9452 6898 6388	6	1.3306 5767 6236	7
15	RE	-3.4805 3464 1381	5	-9.6010 3374 3967	5	-2.6403 9652 7906	6	-7.2426 0444 7187	6
	IM	6.8645 3559 9459	5	1.8199 7154 6502	6	4.8266 2348 4301	6	1.2804 9735 7588	7
16	RE	-7.5167 3140 2476	5	-2.0153 0062 4603	6	-5.4012 5987 3627	6	-1.4472 4137 7856	7
	IM	8.8804 9015 5500	4	2.0511 8176 7217	5	4.6696 1005 2026	5	1.0432 9300 4220	6
17	RE	-4.8151 2053 6331	5	-1.2652 8745 1580	6	-3.3263 0995 9812	6	-8.7490 4364 1801	6
	IM	-5.6772 1663 7923	5	-1.5414 4971 5030	6	-4.1801 4667 4652	6	-1.1323 9245 7867	7
18	RE	2.0413 1547 3215	5	5.7740 5854 9925	5	1.6239 7833 8996	6	4.5454 2947 1236	6
	IM	-7.0321 1123 4626	5	-1.8765 6980 1189	6	-5.0072 0705 1751	6	-1.3360 2179 9281	7
19	RE	6.8789 8657 9471	5	1.8549 0121 3141	6	4.9985 1159 9178	6	1.3462 5941 7264	7
	IM	-2.1388 2197 0567	5	-5.4469 7367 6560	5	-1.3865 9300 6436	6	-3.5285 3060 0338	6
20	RE	5.4841 1115 4512	5	1.4538 3272 0621	6	3.8543 0407 2967	6	1.0219 5826 3129	7
	IM	4.4914 0889 0340	5	1.2291 4096 1160	6	3.3583 2233 9284	6	9.1626 5322 3167	6

COMPLEX FRESNEL INTEGRAL TABLE

X

Y		20	
0	RE	4.4455 3789 9051	7
	IM	-7.0710 6781 1865	-1
1	RE	2.4981 6129 7490	7
	IM	3.6734 5206 6040	7
2	RE	-1.6299 6803 5960	7
	IM	4.1225 8822 4053	7
3	RE	-4.3111 0591 6751	7
	IM	9.6522 5215 6392	6
4	RE	-3.2045 6726 4630	7
	IM	-3.0105 4840 5258	7
5	RE	6.8940 2668 2847	6
	IM	-4.3159 7395 8725	7
6	RE	3.9323 4955 9769	7
	IM	-1.8356 7922 9789	7
7	RE	3.6927 9527 1633	7
	IM	2.2117 7656 6480	7
8	RE	2.3004 6505 6304	6
	IM	4.2593 9663 0155	7
9	RE	-3.3707 5109 8814	7
	IM	2.5449 5777 8729	7
10	RE	-3.9504 9307 3202	7
	IM	-1.3630 2731 9071	7
11	RE	-1.0572 3091 9803	7
	IM	-3.9948 7483 1240	7
12	RE	2.6993 1377 5292	7
	IM	-3.0650 5319 8798	7
13	RE	3.9993 3086 3599	7
	IM	5.3461 8830 3222	6
14	RE	1.7525 2472 9485	7
	IM	3.5787 8553 5038	7
15	RE	-1.9822 5617 0415	7
	IM	3.3985 5245 3783	7
16	RE	-3.8771 8590 8823	7
	IM	2.2725 0506 7330	6
17	RE	-2.3025 4652 3935	7
	IM	-3.0648 6825 8793	7
18	RE	1.2669 7374 1261	7
	IM	-3.5649 1043 4549	7
19	RE	3.6243 0439 9329	7
	IM	-8.9767 7391 0743	6
20	RE	2.7102 1361 9640	7
	IM	2.4967 0779 7292	7

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